Dr. Babasaheb Ambedkar Technological University (Established as University of Technology in the State of Maharashtra)
(Under Maharashtra Act No. XXIX of 2014)
P.O. Lonere, Dist. Raigad, Pin 402 103,
Maharashtra Telephone and Fax. 02140 - 275142
www.dbatu.ac.in

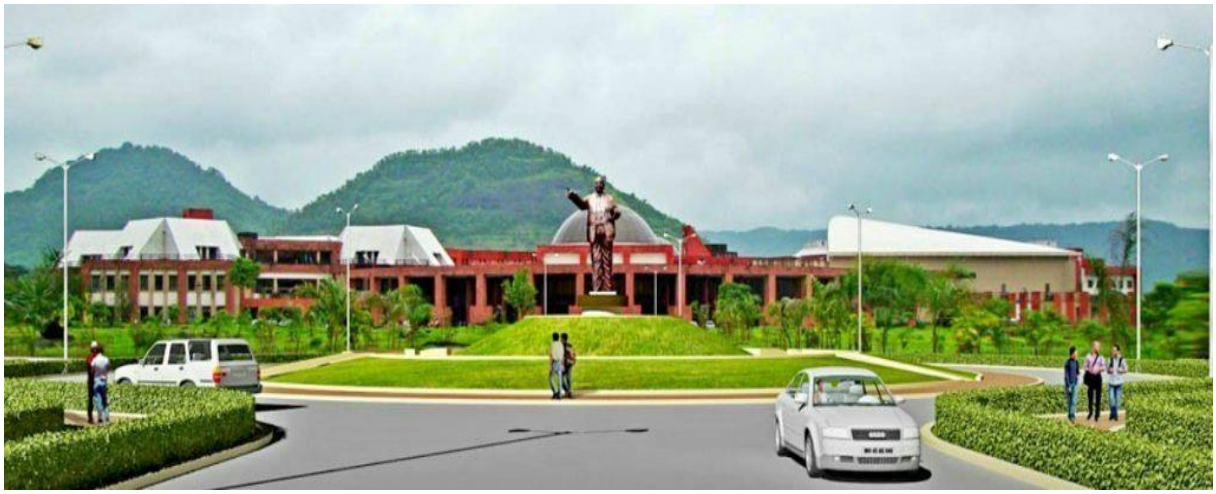
PROPOSED CURRICULUM

UNDER GRADUATE PROGRAMME

B.TECH

PRODUCTION ENGINEERING

WITH EFFECT FROM THE ACADEMIC YEAR 2020-2021.



Vision

The vision of the department is to achieve excellence in teaching, learning, research and transfer of technology and overall development of students.

Mission

Imparting quality education, looking after holistic development of students and conducting need based research and extension.

Graduate Attributes

The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These Graduate Attributes identified by National Board of Accreditation are as follows:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Educational Objectives

PEO1	Graduates should excel in engineering positions in industry and other organizations that emphasize design and implementation of engineering systems and devices.
PEO2	Graduates should excel in best post-graduate engineering institutes, reaching advanced degrees in engineering and related discipline.
PEO3	Within several years from graduation, alumni should have established a successful career in an engineering-related multidisciplinary field, leading or participating effectively in interdisciplinary engineering projects, as well as continuously adapting to changing technologies.
PEO4	Graduates are expected to continue personal development through professional study and self-learning.
PEO5	Graduates are expected to be good citizens and cultured human beings, with full appreciation of the importance of professional, ethical and societal responsibilities.

Program Outcomes

At the end of the program the student will be able to:

PO1	Apply knowledge of mathematics, science and engineering to analyze, design and evaluate mechanical components and systems using state-of-the-art IT tools.
PO2	Analyze problems of production engineering including manufacturing and industrial systems to formulate design requirements.
PO3	Design, implement and evaluate production systems and processes considering public health, safety, cultural, societal and environmental issues.
PO4	Design and conduct experiments using domain knowledge and analyze data to arrive at valid conclusions.
PO5	Apply current techniques, skills, knowledge and computer based methods and tools to develop production systems.
PO6	Analyze the local and global impact of modern technologies on individual organizations, society and culture.
PO7	Apply knowledge of contemporary issues to investigate and solve problems with a concern for sustainability and eco-friendly environment.
PO8	Exhibit responsibility in professional, ethical, legal, security and social issues.
PO9	Function effectively in teams, in diverse and multidisciplinary areas to accomplish common goals.
PO10	Communicate effectively in diverse groups and exhibit leadership qualities.
PO11	Apply management principles to manage projects in multidisciplinary environment.
PO12	Pursue life-long learning as a means to enhance knowledge and skills.

Rules and Regulations

1. The normal duration of the course leading to B.Tech degree will be EIGHT semesters.
2. The normal duration of the course leading to M.Tech. degree will be FOUR semesters. Each academic year shall be divided into 2 semesters, each of 20 weeks duration, including evaluation and grade finalization, etc. The Academic Session in each semester shall provide for at least 90 Teaching Days, with at least 40 hours of teaching contact periods in a five to six days session per week. The semester that is typically from Mid-July to November is called the ODD SEMESTER, and the one that is from January to Mid-May is called the EVEN SEMESTER. Academic Session may be scheduled for the Summer Session/Semester as well. For 1st year B. Tech and M. Tech the schedule will be decided as per the admission schedule declared by Government of Maharashtra.
3. 3.The schedule of academic activities for a Semester, including the dates of registration, mid-semester examination, end-semester examination, inter-semester vacation, etc. shall be referred to as the Academic Calendar of the Semester, which shall be prepared by the Dean (Academic), and announced at least TWO weeks before the Closing Date of the previous Semester.
4. 4.The Academic Calendar must be strictly adhered to, and all other activities including co-curricular and/or extra -curricular activities must be scheduled so as not to interfere with the Curricular Activities as stipulated in the Academic Calendar.

REGISTRATION:

1. Lower and Upper Limits for Course Credits Registered in a Semester, by a Full-Time Student of a UG/PGProgramme:

A full time student of a particular UG/PGprogramme shall register for the appropriate number of course credits in each semester/session that is within the minimum and maximum limits specific to that UG/PGprogramme as stipulated in the specific Regulations pertaining to that UG/PGprogramme.

2. Mandatory Pre-Registration for higher semesters:

   In order to facilitate proper planning of the academic activities of a semester, it is essential for the every institute to inform to Dean (Academics) and COE regarding details of total no. of electives offered (Course-wise) along with the number of students opted for the same. This information should be submitted within two weeks from the date of commencement of the semester as per academic calendar.
3. PhD students can register for any of PG/PhD courses and the corresponding rules of evaluation will apply.

4. Under Graduate students may be permitted to register for a few selected Post Graduate courses, in exceptionally rare circumstances, only if the DUGC/DPGC is convinced of the level of the academic achievement and the potential in a student.

Course Pre-Requisites:

1. In order to register for some courses, it may be required either to have exposure in, or to have completed satisfactorily, or to have prior earned credits in, some specified courses.
2. Students who do not register on the day announced for the purpose may be permitted LATE REGISTRATION up to the notified day in academic calendar on payment of late fee.
3. REGISTRATION IN ABSENTIA will be allowed only in exceptional cases with the approval of the Dean (Academic) / Principal.
4. A student will be permitted to register in the next semester only if he fulfills the following conditions:

(a) Satisfied all the Academic Requirements to continue with the programme of Studies without termination
(b) Cleared all Institute, Hostel and Library dues and fines (if any) of the previous semesters;
(c) Paid all required advance payments of the Institute and hostel for the current semester;
(d) Not been debarred from registering on any specific ground by the Institute.

EVALUATION SYSTEM:

1. Absolute grading system based on absolute marks as indicated below will be implementeds from academic year 2019-20,starting from I year B.Tech.

Perentage of marks	Letter grade	Grade point
91-100	EX	10.0
86-90	AA	9.0
81-85	AB	8.5
76-80	BB	8.0
71-75	BC	7.5
66-70	CC	7.0
61-65	CD	6.5
56-60	DD	6.0
51-55	DE	5.5

40-50	EE	5.0
<40	EF	0.0

2. Class is awdared based on CGPA of all eigth semster of B.Tech Program.

CGPA for pass is minimum 5.0	
CGPAupto<5.50	Pass class
CGPA ≥ 5.50 &<6.00	SecondClass
CGPA ≥ 6.00 &<7.50	First Class
CGPA ≥ 7.50	Distinction
[Percentage of Marks =CGPA*10.0]	

3. A total of 100 Marks for each theory course are distributed as follows:

1.	MidSemester Exam (MSE) Marks	20
2.	ContinuousAssesment Marks	20
3.	EndSemesterExamination(ESE)Marks	60

4.A total of 100 Marks for each practical course are distributed as follows:

1.	Continuous Assesment Marks	60
2.	End Semester Examination (ESE)Marks	40

It is mandatory for every student of B.Tech to score a minimum of 40 marks out of 100, with a minimum of 20 marks out of 60 marks in End Semester Examination for theory course.

This will be implemented from the first year of B.Tech starting from Academic Year 2019-20

5. Description of Grades:

EX Grade: An 'EX' grade stands for outstanding achievement.
EE Grade: The 'EE' grade stands for minimum passing grade.
The students may appear for the remedial examination for the subjects he/she failed for the current semester of admission only and his/her performance will be awarded with EE grade only.
If any of the student remain Absent for the regular examination due to genuine reason and the same will be verified and tested by the Dean (Academics) or committee constituted by the University Authority.
FF Grade: The 'FF' grade denotes very poor performance, i.e. failure in a course due to poor performance .The students who have been awarded

'FF' grade in a course in any semester must repeat the subject in next semester.

6. Evaluation of Performance:

1. Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA)

(A) Semester Grade Point Average (SGPA) The performance of a student in a semester is indicated by Semester Grade Point Average (SGPA) which is a weighted average of the grade points obtained in all the courses taken by the student in the semester and scaled to a maximum of 10. (SGPI is to be calculated up to two decimal places). A Semester Grade Point Average (SGPA) will be computed for each semester as follows:

$$SGPA = \frac{[\sum_{i=1}^{n} c_i g_i]}{[\sum_{i=1}^{n} c_i]}$$

Where
'n' is the number of subjects for the semester,
'ci' is the number of credits allotted to a particular subject, and
'gi' is the grade-points awarded to the student for the subject based on his performance as
per the above table.
-SGPA will be rounded off to the second place of decimal and recorded as such.

(B) Cumulative Grade Point Average (CGPA): An up to date assessment of the overall performance of a student from the time he entered the Institute is obtained by calculating Cumulative Grade Point Average (CGPA) of a student. The CGPA is weighted average of the grade points obtained in all the courses registered by the student since s/he entered the Institute. CGPA is also calculated at the end of every semester (upto two decimal places).Starting from the first semester at the end of each semester (S), a Cumulative Grade Point Average (CGPA) will be computed as follows:

$$CGPA = \frac{[\sum_{i=1}^{m} c_i g_i]}{[\sum_{i=1}^{m} c_i]}$$

Where
'm' is the total number of subjects from the first semester onwards up to and

including the
semester S,
'ci' is the number of credits allotted to a particular subject, and
'gi' is the grade-points awarded to the student for the subject based on his/her performance as per the above table.

-CGPA will be rounded off to the second place of decimal and recorded as such.

Award of Degree of Honours

Major Degree

The concept of Major and Minors at B.Tech level is introduced , to enhance learning skills of students, acquisition of additional knowledge in domains other than the discipline being pursued by the student, to make the students better employable with additional knowledge and encourage students to pursue cross-discipline research.

A. Eligibility Criteria for Majors

1. The Student should have Minimum CGPA of 7.5 up to 4th Semester
2. Student willing to opt for majors has to register at the beginning of 5th Semester
3. The Student has to complete 5 additional advanced courses from the same discipline specified in the curriculum. These five courses should be of 4 credits each amounting to 20 credits. The students should complete these credits before the end of last semester.
4. Student may opt for the courses from NPTEL/ SWAYAM platform. (if the credits of NPTEL/ SWAYAM courses do not match with the existing subject proper scaling will be done)

Student complying with these criteria will be awarded B.Tech (Honours) Degree.

B. Eligibility Criteria for Minors

1. The Student should have Minimum CGPA of 7.5 up to 4th Semester
2. Student willing to opt for minors has to register at the beginning of 5th Semester
3. The Student has to complete 5 additional courses from other discipline of their interest, which are specified in the respective discipline. These five courses should be of 4 credits each amounting to 20 credits.
4. Student may opt for the courses from NPTEL/ SWAYAM platform. (if the credits of NPTEL/ SWAYAM courses do not match with the existing subject proper scaling will be done)

Student complying with these criteria will be awarded with B.Tech Degree in -------Engineering with Minor in ------ --Engineering.
(For e.g.: B. Tech in Civil Engineering with Minor in Computer Engineering)

For applying for Honours and Minor Degree the student has to register themselves through the proper system.

ATTENDANCE REQUIREMENTS:

1. All students must attend every lecture, tutorial and practical classes.
2. To account for approved leave of absence (eg. representing the Institute in sports, games or athletics; placement activities; NCC/NSS activities; etc.) and/or any other such contingencies like medical emergencies, etc., the attendance requirement shall be a minimum of 75% of the classes actually conducted.

If the student failed to maintain 75% attendance, he/she will be detained for appearing the successive examination.

The Dean (Academics)/ Principal is permitted to give 10% concession for the genuine reasons as such the case may be.

In any case the student will not be permitted for appearing the examination if the attendance is less than 65%.

3. The course instructor handling a course must finalize the attendance 3 calendar days before the last day of classes in the current semester and communicate clearly to the students by displaying prominently in the department and also in report writing to the head of the department concerned.
4. The attendance records are to be maintained by the course instructor and he shall show it to the student, if and when required.

TRANSFER OF CREDITS

The courses credited elsewhere, in Indian or foreign University/Institutions/ Colleges/Swayam Courses by students during their study period at DBATU may count towards the credit requirements for the award of degree. The guidelines for such transfer of credits are as follows:

a) 20 % of the total credit will be considered for respective calculations.

b) Credits transferred will be considered for overall credits requirements of the programme.

c) Credits transfer can be considered only for the course at same level i.e UG, PG etc.

d) A student must provide all details (original or attested authentic copies)such as course contents, number of contact hours, course instructor /project guide and evaluation system for the course for which he is requesting a credits transfer. He shall also provide the approval or acceptance letter from the other side. These details will be evaluated by the concerned Board of Studies before giving approval. The Board of Studies will then decide the number of equivalent credits the student will get for such course(s) in DBATU. The complete details will then be forwarded to Dean for approval.

e) A student has to get minimum passing grades/ marks for such courses for which the credits transfers are to be made.

f) Credits transfers availed by a student shall be properly recorded on academic record(s) of the student.
g) In exceptional cases, the students may opt for higher credits than the prescribed.

Abbreviations

BSC: *Basic Science Course*

ESC: *Engineering Science Course*

PCC: *Professional Core Course*

PEC: *Professional Elective Course*

OEC: *Open Elective Course*

HSSMC: *Humanities and Social Science including Management Courses*

PROJ: *Project work, seminar and internship in industry or elsewhere*

DEPARTMENT OF PRODUCTION ENGINEERING
Bachelor of Technology in PRODUCTION Engineering

Basic Science Course (BSC)		
BTBS101	Engineering Mathematics- I	(3-1-0)4
BTBS102	Engineering Physics	(3-1-0)4
BTBS107L	Engineering Physics Lab	(0-0-2)1
BTBS201	Engineering Mathematics-II	(3-1-0)4
CHM202	Engineering Chemistry	(3-1-0)4
BTBS207L	Engineering Chemistry Lab	(0-0-2)1
BTBS301	Engineering Mathematics – III	(3-1-0)4

Engineering Science Course (ESC)		
BTES103	Engineering Graphics	(2-0-0)2
BTES105	Energy and Environment Engineering	(2-0-0)2
BTES106	Basic Civil & Mechanical Engineering	(2-0-0) Audit
BTES108L	Engineering Graphics Lab	(0-0-4)2
BTES203	Engineering Mechanics	(2-1-0)3
BTES204	Computer Programming	(3-0-0)3
BTES205	Basic Electrical and Electronics Engineering	(2-0-0) Audit
BTES206L	Workshop Practice	(0-0-4)2
BTES208L	Engineering Mechanics Lab	(0-0-2)1
BTMES304	Materials Science and Metallurgy	(3-1-0)4
BTMES404	Strength of Materials	(3-1-0)4
Online course	Artificial Intelligence*	(3-0-0)3
Humanities and Social Science Including Management Courses (HSSMC)		
BTHM104	Communication Skills	(2-0-0)2
BTHM109L	Communication Skills Lab	(0-0-2)1
BTHM403	Basic Human Rights	(3-0-0)3
BTHM702	Industrial Engineering and Management	(3-1-0)4
	Constitution of India*	(1-0-0)1
Professional Core Course (PCC)		
BTMC302	Fluid Mechanics	(3-1-0)4
BTAC303	Engineering Thermodynamics & Heat Transfer	(3-1-0)4
BTMCL305	Machine Drawing and CAD Lab	(0-0-4)2
BTPCL306	Production Engineering Lab I	(0-0-6)3
BTPC401	Casting &Moulding Technology	(3-1-0)4
BTPC402	Theory of Machines	(3-1-0)4
BTPCL406	Production Engineering Lab II	(0-0-4)2
BTPC501	Design of Machine Elements	(3-1-0)4
BTPC502	Metal Forming Processes	(3-1-0)4
BTPC503	Joining Technology	(3-1-0)4
BTPC506	Metrology and Quality Control	(3-1-0)4
BTPCL506	Production	(0-0-4)2

	Engineering Lab III	
BTPC601	Machine Tools and Metal Cutting	(3-1-0)4
BTPC602	CAD/CAM/CIM	(3-1-0)4
BTPCL606	Production Engineering Lab IV	(0-0-4)2
BTMC701	Mechatronics	(3-1-0)4
BTPCL706	Production Engineering Lab V	(0-0-4)2
Professional Elective Course (PEC)		
BTMPE405A	Numerical Methods in Mechanical Engineering	(3-1-0)4
BTMPE405B	Sheet Metal Engineering	(3-1-0)4
BTMPE405C	Fluid Machinery	(3-1-0)4
BTMPE504A	Refrigeration and Air conditioning	(3-0-0)3
BTMPE504C	Engineering Tribology	(3-0-0)3
BTAPE504A	Automobile Design	(3-0-0)3
BTAPE504D	Automobile Engineering	(3-0-0)3
BTPPE603A	Robotics & Automation	(3-1-0)4
BTPPE603B	Assembly Planning & Management	(3-1-0)4
BTMPE603A	IC Engines	(3-1-0)4
BTMPE603B	Mechanical Vibrations	(3-1-0)4
BTMPE603C	Machine Tool Design	(3-1-0)4
BTAPE603C	Automobile Body	(3-1-0)4

	Design (Pre-requisite:Automobile Design)	
BTPPE604A	Production Planning and Control	(3-1-0)4
BTPPE604B	Flexible Manufacturing Systems	(3-1-0)4
BTMPE604A	Process Equipment Design	(3-1-0)4
BTMPE604B	Product Life Cycle Management	(3-1-0)4
BTMPE604C	Finite Element Method	(3-1-0)4
BTAPE604B	Computational Fluid Dynamics	(3-1-0)4
BTPPE703A	Tool Design	(3-0-0)3
BTPPE703B	Reliability and Terotechnology	(3-0-0)3
BTPPE703C	Modeling of Manufacturing Systems	(3-0-0)3
BTPPE703D	Processing of Polymers	(3-0-0)3
BTMPE703B	Biomechanics	(3-0-0)3
BTMPE703C	Non-conventional Machining	(3-0-0)3
BTMPE703E	Additive Manufacturing	(3-0-0)3
BTMPE703F	Surface Engineering	(3-0-0)3
Open Elective Course (OEC)		
BTMOE505A	Solar Energy	(3-0-0)3
BTMOE505B	Renewable Energy Sources	(3-0-0)3

BTMOE505C	Human Resource Management	(3-0-0)3
BTMOE505D	Product Design Engineering	(3-0-0)3
BTMOE605A	Quantitative Techniques and Project Management	(3-1-0)4
BTMOE605B	Nanotechnology	(3-1-0)4
BTMOE605C	Energy Conservation and Management	(3-1-0)4
BTMOE605D	Wind Energy	(3-1-0)4
BTMOE605E	Introduction to Probability Theory and Statistics	(3-1-0)4
BTMOE704A	Sustainable Development	(3-0-0)3
BTMOE704B	Entrepreneurship Development	(3-0-0)3
BTMOE704C	Plant Maintenance	(3-0-0)3
BTMOE705A	Engineering Economics	(3-0-0)3
BTMOE705B	Biology for Engineers	(3-0-0)3
BTMOE705C	Intellectual Property Rights	(3-0-0)3
Seminar/Mini Project/ Internship		
BTES209P	IT – 1 Evaluation	(0-0-2)1

BTPI407	IT – 2 Evaluation	(0-0-2)1
BTPS 607	B Tech Seminar	(0-0-2)1
BTPP 608	Mini Project	(0-0-2)2
BTPI609	IT – 3 Evaluation	(0-0-2)1
Project (MP)		
BTPP801/ BTPI801	Project work/ Internship	(0-0-24)12

Suggested Plan of Study

Number of Courses	Semester							
	I	II	III	IV	V	VI	VII	VIII
1	BTBS101 Engineering Mathematics- I	BTBS201 Engineering Mathematics-II	BTBS301 Engineering Mathematics – III	BTPC401 Casting &Moulding Technology	BTPC501 Design of Machine Elements	BTPC601 Machine Tools and Metal Cutting	BTMC701 Mechatronics	BTPP801/ BTPI801 Project work/ Internship
2	BTBS102 Engineering Physics	CHM202 Engineering Chemistry	BTMC302 Fluid Mechanics	BTPC402 Theory of Machines	BTPC502 Metal Forming Processes	BTPC602 CAD/CAM/CIM	BTHM702 Industrial Engineering and Management	--
3	BTES103 Engineering Graphics	BTES203 Engineering Mechanics	BTAC303 Engineering Thermodynamics and heat transfer	BTHM403 Basic Human Rights	BTPC503 Joining Technology	BTPPE603/ BTMPE603/ BTAPE603 Elective-III	BTPPE703/ BTMPE703 Elective-V	--
4	BTHM104 Communication Skills	BTES204 Computer Programming	BTMES304 Materials Science and Metallurgy	BTMES404 Strength of Materials	BTMPE504/ BTAPE504 Elective-II	BTPPE604/ BTMPE604/ BTAPE604 Elective-IV	BTMOE704 Open Elective-III	--
5	BTES105 Energy and Environment Engineering	BTES205 Basic Electrical and Electronics Engineering	BTMCL305 Machine Drawing and CAD Lab	BTMPE405 Elective-I	BTMOE505 Open Elective-I	BTMOE605 Open Elective-II	BTMOE705 Open Elective-IV	--
6	BTES106 Basic Civil and Mechanical Engineering	BTES206L Workshop Practice	BTPCL306 Production Engineering Lab I	BTPCL406 Production Engineering Lab II	BTPC506 Metrology and Quality Control	BTPCL606 Production Engineering Lab IV	BTPCL706 Production Engineering Lab V	--
7	BTBS107L Engineering Physics Lab	BTBS207L Engineering Chemistry Lab	BTES209P (IT – 1 Evaluation)	BTPI407 (IT – 2)	BTPCL507 Production Engineering Lab III	BTPS607 B Tech Seminar	BTPI609 (IT – 3 Evaluation)	--
8	BTES108L Engineering Graphics Lab	BTES208L Engineering Mechanics Lab	Constitution of India	--	BTPI407 (IT – 2 Evaluation)	BTPP608 Mini Project	---	--
9	BTHM109L Communication Skills Lab	BTES209P (IT - 1)	--	--	Artificial Intelligence	BTPI609 (IT – 3)--	-	--
10	--		--	--	--		--	--

Course Structure for Semester I
B. Tech. in Production Engineering (w.e.f. 2020-21)

Semester I									
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**			
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	**No. of Credits**
	Mandatory	***Induction Program***	***3-weeks duration in the beginning of the semester***							
BSC1	BTBS101	Engineering Mathematics- I	3	1	-	20	20	60	100	4
BSC2	BTBS102	Engineering Physics	3	1	-	20	20	60	100	4
ESC1	BTES103	Engineering Graphics	2	-	-	20	20	60	100	2
HSSMC1	BTHM104	Communication Skills	2	-	-	20	20	60	100	2
ESC2	BTES105	Energy and Environment Engineering	2	-	-	20	20	60	100	2
ESC3	BTES106	Basic Civil and Mechanical Engineering	2	-	-	50	-	-	50	Audit
BSC3	BTBS107L	Engineering Physics Lab	-	-	2	60	-	40	100	1
ESC4	BTES108L	Engineering Graphics Lab	-	-	3	60	-	40	100	2
HSSMC2	BTHM109L	Communication Skills Lab	-	-	2	60	-	40	100	1
		Total	**14**	**2**	**7**	**330**	**100**	**420**	**850**	**18**

Course Structure for Semester II
B. Tech. in Production Engineering (w.e.f. 2020-21)

Semester II									
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**			
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	**No. of Credits**
BSC4	BTBS201	Engineering Mathematics-II	3	1	-	20	20	60	100	4
BSC5	CHM202	Engineering Chemistry	3	1	-	20	20	60	100	4
ESC5	BTES203	Engineering Mechanics	2	1	-	20	20	60	100	3
ESC6	BTES204	Computer Programming	3	-	-	20	20	60	100	3
ESC7	BTES205	Basic Electrical and Electronics Engineering	2	-	-	50	-	-	50	Audit
ESC8	BTES206L	Workshop Practice	-	-	4	60	-	40	100	2
BSC6	BTBS207L	Engineering Chemistry Lab	-	-	2	60	-	40	100	1
ESC9	BTES208L	Engineering Mechanics Lab	-	-	2	60	-	40	100	1
PROJ-1	BTES209P (IT – 1)	Field Training / Industrial Training (minimum of 4 weeks which can be completed partially in first semester and second Semester or in one semester itself)	-	-	-	-	-	-	-	To be evaluated in Sem III
	Mandatory	***NSS/NCC/Sports***	-	-	-	-	-	-	-	**Audit**
		Total	**13**	**3**	**8**	**310**	**80**	**360**	**750**	**18**

Course Structure for Semester III
B.Tech in Production Engineering
(w.e.f. 2021-22)

Semester IV											
Semester III											
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				**Credit**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
BSC7	BTBS301	Engineering Mathematics – III	3	1	-	20	20	60	100	4
PCC 1	BTMC302	Fluid Mechanics	3	1	-	20	20	60	100	4
PCC 2	BTAC303	Engineering Thermodynamics and heat transfer	3	1	--	20	20	60	100	4
ESC10	BTMES304	Materials Science and Metallurgy	3	1	-	20	20	60	100	4
PCC3	BTMCL305	Machine Drawing and CAD Lab	-	-	4	60	-	40	100	2
PCC4	BTPCL306	Production Engineering Lab I	-	-	6	60	-	40	100	3
PROJ-1	BTES209P (IT – 1)	IT – 1 Evaluation	-	-	-	-	-	100	100	1
		Constitution of India*								Audit
		Total	**12**	**4**	**10**	**200**	**80**	**420**	**700**	**22**

Course Structure for Semester IV
B.Tech in Production Engineering
(w.e.f. 2021-22)

Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				Credit
			L	T	P	CA	MSE	ESE	Total	
PCC 5	BTPC401	Casting &Moulding Technology	3	1	-	20	20	60	100	4
PCC 6	BTPC402	Theory of Machines	3	1	-	20	20	60	100	4
HSSMC3	BTHM403	Basic Human Rights	3	-	-	20	20	60	100	3
ESC11	BTMES404	Strength of Materials	3	1	-	20	20	60	100	4
PEC 1	BTMPE405	Elective-I	3	1	-	20	20	60	100	4
PCC7	BTPCL406	Production Engineering Lab II	-	-	4	60	-	40	100	2
PROJ-2	BTPI407 (IT – 2)	Field Training / Industrial Training (minimum of 4 weeks which can be completed partially in third semester and fourth semester or in at one time).	-	-	-	-	-	-	-	Credits to be evaluated in V Sem.
		Total	**15**	**4**	**6**	**220**	**100**	**380**	**700**	**22**

Elective I

Sr. No.	Course code	Course Name
1	BTMPE405A	Numerical Methods in Mechanical Engineering
2	BTMPE405B	Sheet Metal Engineering
3	BTMPE405C	Fluid Machinery

Course Structure for Semester V
B.Tech in Production Engineering
(w.e.f. 2022-23)

Semester V										
Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				Credit
			L	T	P	CA	MSE	ESE	Total	
PCC 8	BTPC501	Design of Machine Elements	3	1	--	20	20	60	100	4
PCC 9	BTPC502	Metal Forming Processes	3	1	--	20	20	60	100	4
PCC 10	BTPC503	Joining Technology	3	1	-	20	20	60	100	4
PEC 2	BTMPE504/ BTAPE504	Elective-II	3	-	-	20	20	60	100	3
OEC 1	BTMOE505	Open Elective-I	3	-	-	20	20	60	100	3

PCC11	BTPC6	Metrology and Quality control	3	1	-	20	20	60	100	4
PCC12	BTPCL507	Production Engineering Lab III	-	-	4	60	-	40	100	2
PROJ-2	BTPI407 (IT – 2)	IT – 2 Evaluation	-	-	-	-	-	100	100	1
		Artificial Intelligence*	3							3*
		Total	**18+ 3**	**4**	**4**	**180**	**120**	**500**	**800**	**25+3***

Elective II

Sr. No.	**Course code**	**Course Name**
1	BTMPE504A	Refrigeration and Air conditioning
2	BTMPE504C	Engineering Tribology
3	BTAPE504A	Automobile Design
4	BTAPE504D	Automobile Engineering

Open Elective I

Sr. No.	**Course code**	**Course Name**
1	BTMOE505A	Solar Energy
2	BTMOE505B	Renewable Energy Sources
3	BTMOE505C	Human Resource Management
4	BTMOE505D	Product Design Engineering

*over and above of 160 credits

Course Structure for Semester VI
B.Tech in Production Engineering
(w.e.f. 2022-23)

Semester VI									
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				**Credit**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
PCC 12	BTPC601	Machine Tools and Metal Cutting	3	1	--	20	20	60	100	4
PCC 13	BTPC602	CAD/CAM/CIM	3	1	--	20	20	60	100	4
PEC 3	BTPPE603 BTMPE603 BTAPE603	Elective-III	3	1	-	20	20	60	100	4
PEC 4	BTPPE604 BTMPE604 BTAPE604	Elective-IV	3	1	-	20	20	60	100	4
OEC 2	BTMOE605	Open Elective-II	3	1	-	20	20	60	100	3

PCC14	BTPCL606	Production Engineering Lab IV	-	-	4	60	-	40	100	2
PROJ-3	BTPS607	B Tech Seminar	-	-	2	60	-	40	100	1
PROJ-4	BTPP608	Mini Project – 2	-	-	2	60	-	40	100	2
PROJ-5	BTPI609 (IT – 3)	Field Training / Industrial Training (minimum of 4 weeks which can be completed partially in third semester and fourth semester or in at one time).	-	-	-	-	-	-	-	Credits To be evaluated in VII Sem.
		Total	**15**	**5**	**8**	**280**	**100**	**420**	**800**	**24**

Elective III:

Sr. No.	Course code	Course Name
1	BTPPE603A	Robotics & Automation
2	BTPPE603B	Assembly Planning & Management
3	BTMPE603A	IC Engines
4	BTMPE603B	Mechanical Vibrations
5	BTMPE603C	Machine Tool Design
6	BTAPE603C	Automobile Body Design (Pre-requisite: Automobile Design)

Elective IV:

Sr. No.	Course code	Course Name
1	BTPPE604A	Production Planning and Control
2	BTPPE604B	Flexible Manufacturing Systems
3	BTMPE604A	Process Equipment Design
4	BTMPE604B	Product Life Cycle Management
5	BTMPE604C	Finite Element Method
6	BTAPE604B	Computational Fluid Dynamics

Open Elective II:

Sr. No.	Course code	Course Name
1	BTMOE605A	Quantitative Techniques and Project Management
2	BTMOE605B	Nanotechnology
3	BTMOE605C	Energy Conservation and Management
4	BTMOE605D	Wind Energy

5	BTMOE605E	Introduction to Probability Theory and Statistics

Course Structure for Semester VII
B.Tech in Production Engineering
(w.e.f. 2023-24)

Semester VII										
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				**Credit**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
PCC 15	BTMC701	Mechatronics	3	1	-	20	20	60	100	4
HSSMC4	BTHM702	Industrial Engineering and Management	3	1	-	20	20	60	100	4
PEC 5	BTPPE703 BTMPE703	Elective-V	3	-	-	20	20	60	100	3
OEC 3	BTMOE704	Open Elective-III	3	-	-	20	20	60	100	3
OEC 4	BTMOE705	Open Elective-IV	3	-	-	20	20	60	100	3
PCC16	BTPCL706	Production Engineering Lab V	-	-	4	60	-	40	100	2
PROJ-5	BTPI608 (IT – 3)	IT – 3 Evaluation	-	-	-	-	-	100	100	1
		Total	**15**	**2**	**04**	**160**	**100**	**440**	**700**	**20**

Elective V:

Sr. No.	**Course code**	**Course Name**
1	BTPPE703A	Tool Design
2	BTPPE703B	Reliability and Terotechnology
3	BTPPE703C	Modeling of Manufacturing Systems

4	BTPPE703D	Processing of Polymers
5	BTMPE703B	Biomechanics
6	BTMPE703C	Non-conventional Machining
7	BTMPE703E	Additive Manufacturing
8	BTMPE703F	Surface Engineering

Open Elective IV:

Sr. No.	Course code	Course Name
1	BTMOE705A	Engineering Economics
2	BTMOE705B	Biology for Engineers
3	BTMOE705C	Intellectual Property Rights

Open Elective III:

Sr. No.	Course code	Course Name
1	BTMOE704A	Sustainable Development
2	BTMOE704B	Entrepreneurship Development
3	BTMOE704C	Plant Maintenance

Course Structure for Semester VIII
B.Tech in Production Engineering
(w.e.f. 2023-24)

Semester VIII										
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				**Credit**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
PROJ-6	BTPP801/ BTPI801	Project work/ Internship	-	-	24	60	-	40	100	12
		Total	**-**	**-**	**24**	**60**	**-**	**40**	**100**	**12**

Total Credits: 160

Sr. No.	Category	Number of Subjects in Each Category	Suggested Breakup of Credits by AICTE (Total 160)	Total
1	Humanities and Social Sciences including Management courses	4	12	**10**
2	Basic Science courses	7+1*	25	**22+3***
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc.	11	24	**23**
4	Professional core courses	17	48	**59**
5	Professional Elective courses relevant to chosen specialization/branch	5	18	**16**
6	Open subjects – Electives from other technical	4	18	**12**

	and /or emerging subjects			
7	Project work, seminar and internship in industry or elsewhere	6	15	**18**
8	Mandatory Courses [Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Knowledge Tradition]	2+1*	NC	--
	Total	**56+2**	**160***	**160**

S. N.	Category	Suggested Breakup of Credits (Total 160)	First year		Second year		Third year		Final year		Total
			I	II	III	IV	V	VI	VII	VIII	
1	Humanities and Social Sciences including Management courses	12	03	--	--	03		--	04	--	**10**
2	Basic Science courses	25	09	09	04	3*	--	--	--	--	**22+3***
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc.	24	06	09	04	04	--	--	--	--	**23**
4	Professional core courses	48	--	--	12	10	19	11	07	--	**59**
5	Professional Elective courses relevant to chosen specialization/branch	18	--	--	--	04	03	06	03	--	**16**
6	Open subjects – Electives from other technical and /or emerging subjects	18	--	--	--	--	03	03	06	--	**12**
7	Project work, seminar and internship in industry or elsewhere	15	--	--	01	--	01	03	01	12	**18**

8	Mandatory Courses [Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Knowledge Tradition]	NC	--	--	--	--	--	--	--	--	--
	Semester wise credits		18	18	21	21 +3*	26	23	21	12	**160**
	Total	**160***	**37**		**44**		**45**		**34**		

SEMESTER I
Guide to Induction Program

When new students enter an institution, they come with diverse thoughts, backgrounds and preparations. It is important to help them adjust to the new environment and inculcate in them the ethos of the institution with a sense of larger purpose. Precious little is done by most of the institutions, except for an orientation program lasting a couple of days.

We propose a 3-week long induction program for the UG students entering the institution, right at the start. Normal classes start only after the induction program is over. Its purpose is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The time during the Induction Program is also used to rectify some critical lacunas, for example, English background, for those students who have deficiency in it.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

- **Physical Activity** This would involve a daily routine of physical activity with games and sports. It would start with all students coming to the field at 6 am for light physical exercise or yoga. There would also be games in the evening or at other suitable times according to the local climate. These would help develop team work. Each student should pick one game and learn it for three weeks. There could also be gardening or other suitably designed activity where labour yields fruits from nature.
- **Creative Arts** Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it every day for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, flow into engineering design later.
- **Universal Human Values:** It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting staff in the hostel and department, be sensitive to others, etc. Need for character building has been underlined earlier. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and dont's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing. The role of group discussions, however, with clarity of thought of the teachers cannot be over emphasized. It is

essential for giving exposure, guiding thoughts, and realizing values. The teachers must come from all the departments rather than only one department like HSS or from outside of the Institute. Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It is to open thinking towards the self. Universal Human Values discussions could even continue for rest of the semester as a normal course, and not stop with the induction program. Besides drawing the attention of the student to larger issues of life, it would build relationships between teachers and students which last for their entire 4-year stay and possibly beyond.

- **Literary** Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.
- **Proficiency Modules:** This period can be used to overcome some critical lacunas that students might have, for example, English, computer familiarity etc. These should run like crash courses, so that when normal courses start after the induction program, the student has overcome the lacunas substantially. We hope that problems arising due to lack of English skills, wherein students start lagging behind or failing in several subjects, for no fault of theirs, would, hopefully, become a thing of the past.
- **Lectures by Eminent People** This period can be utilized for lectures by eminent people, say, once a week. It would give the students exposure to people who are socially active or in public life.**Visits to Local Area** A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.
- **Familiarization to Dept./Branch & Innovations :** The students should be told about different method of study compared to coaching that is needed at IITs. They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilties.

Schedule

The activities during the Induction Program would have an ***Initial Phas***e, a ***Regular Phase*** and a ***Closing Phase***. The Initial and Closing Phases would be two days each.

Initial Phase

Time	Activity
Day 0	
Whole day	Students arrive - Hostel allotment. (Preferably do preallotment)
Day 1	
9.00 AM to 3.00 PM	Academic Registration
4.30 PM to 6.00 PM	Ori Orientation
Day 2	
9.00 AM to 10.00 AM	Diagnostic test (for English etc.) Visi
10.15 AM to 12.25 PM	Visits to Respective Departments
12.30 to 2.00	Lunch time
2.00 PM to 3.00 PM	Director’s Speech
3.00 PM to 4.00 PM	Interaction with Parents
4.00 PM to 5.30 PM	Mentor-Mentee groups- Introduction within group

Regular Phase

After two days is the start of the Regular Phase of induction. With this phase there would be regular program to be followed every day.

Daily Schedule

Some of the activities are on a daily basis, while some others are at specified periods within the Induction Program. We first show a typical daily timetable.

Session	Time	Activity	Remark

Day 3 Onwards			
I	9.00 AM to 11.00 AM	Creative Arts / Universal Human Values	Half the groups will do creative arts
II	11.00 AM to 1.00 PM	Universal Human Values/ Creative Arts	Complementary Alternate
Lunch Time			
IV	2.00 PM to 4.00 PM	Afternoon Session	See below
V	4.00 PM to 5.00 PM	Afternoon Session	See below

Sundays are off. Saturdays have the same schedule as above or have outing.

Afternoon Activities (Non-Daily) : The following five activities are scheduled at different times of the Induction Program, and are not held daily for everyone:
1. Familiarization to Dept./Branch & Innovations
2. Visits to Local Area
3. Lectures by Eminent People
4. Literary
5. Proficiency Modules

Closing Phase

Time	Activity
Last But one day	
9.00 AM to 12.00 PM	Discussions and finalizations of presentations within each group
2.00 PM to 5.00 PM	Presentation by each group in front of 4 other groups besides their own (about 100 students)
Last Day	
Whole day	Examinations if any

Follow Up after Closure

A question comes up as to what would be the follow up program after the formal 3-week Induction Program is over? The groups which are formed should function as mentor- mentee network. A student should feel free to approach his faculty mentor or the student guide, when facing any kind of problem, whether academic or financial or psychological 6etc. (For every 10 undergraduate first year students, there would be a senior student as a student guide, and for every 20 students, there would be a faculty mentor.) Such a group should remain for the entire 4-5 year duration of the stay of the student. Therefore, it would be good to have groups with the students as well as teachers from the same department/discipline Here we list some important suggestions which have come up and which have been experimented with.

 Follow Up after Closure – Same Semester: It is suggested that the groups meet with their faculty mentors once a month, within the semester after the 3-week Induction Program is over. This should be a scheduled meeting shown in the timetable. (The groups are of course free to meet together on their own more often, for the student groups to be invited to their faculty mentor's home for dinner or tea, nature walk, etc.)
 Follow Up – Subsequent Semesters: It is extremely important that continuity be maintained in subsequent semesters. It is suggested that at the start of the subsequent semesters (upto fourth semester), three days be set aside for three full days of activities related to follow up to Induction Program. The students be shown inspiring films, do collective art work, and group discussions be conducted. Subsequently, the groups should meet at least once a month.

Summary

Engineering institutions were set up to generate well trained manpower in engineering with a feeling of responsibility towards oneself, one's family, and society. The incoming undergraduate students are driven by their parents and society to join engineering without understanding their own interests and talents. As a result, most students fail to link up with the goals of their own institution. The graduating student must have values as a human being, and knowledge and meta-skills related to his/her profession as an engineer and as a citizen. Most students who get demotivated to study engineering or their branch, also lose interest in learning.
The Induction Program is designed to make the newly joined students feel comfortable, sensitize them towards exploring their academic interests and activities, reducing competition and making them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and building of character.

The Universal Human Values component, which acts as an anchor, develops awareness and sensitivity, feeling of equality, compassion and oneness, draw attention to society and 4
We are aware that there are advantages in mixing the students from different depts. However, in mixing, it is our experience that the continuity of the group together with the faculty mentor breaks down soon after. Therefore, the groups be from the same dept. but hostel wings have the mixed students from different depts. For example, the hostel room allotment should be in alphabetical order irrespective of dept. 7nature, and character to follow through. It also makes them reflect on their relationship with their families and extended family in the college (with hostel staff and others). It also connects students with each other and with teachers so that they can share any difficulty they might be facing and seek help.

References:

Motivating UG Students Towards Studies, Rajeev Sangal, IITBHU Varanasi, Gautam Biswas, IIT Guwahati, Timothy Gonsalves, IIT Mandi, Pushpak Bhattacharya, IIT Patna, (Committee of IIT Directors),
31 March 2016, IIT Directors' Secretariat, IIT Delhi.

BTBS101 Engineering Mathematics – I

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week Tutorial: 1 hrs/week	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

Course Contents:

Unit 1: Linear Algebra- Matrices

Inverse of a matrix by Gauss-Jordan method; Rank of a matrix; Normal form of a matrix ; Consistency of non- homogeneous and homogeneous system of linear equations ; Eigen values and eigen vectors ; Properties of eigen values and eigen vectors (without proofs); Cayley-Hamilton's theorem (without proof) and its applications. **[06 Hours]**

Unit 2: Partial Differentiation

Partial derivatives of first and higher orders; Homogeneous functions – Euler's Theorem for functions containing two and three variables (with proofs); Total derivatives; Change of variables. **[06 Hours]**

Unit 3: Applications of Partial differentiation

Jacobians - properties; Taylor's and Maclaurin's theorems (without proofs) for functions of two variables; Maxima and minima of functions of two variables; Lagrange's method of undetermined multipliers. **[06 Hours]**

Unit 4: Reduction Formulae and Tracing of Curves

Reduction formulae for $\int_0^{\frac{\pi}{2}} sin^n x\, dx, \int_0^{\frac{\pi}{2}} cos^n x\, dx$, $\int_0^{\frac{\pi}{2}} sin^m x\, cos^n x\, dx$; Tracing of standard curves given in Cartesian, parametric & polar forms. **[06 Hours]**

Unit 5: Multiple Integrals

Double integration in Cartesian and polar co-ordinates; Evaluation of double integrals by changing the order of integration and changing to polar form; Triple integral; Applications of multiple integrals to find area as double integral , volume as triple integral and surface area. **[08 Hours]**

Text Books

1. Higher Engineering Mathematics by B. S. Grewal, Khanna Publishers, New Delhi.
2. Higher Engineering Mathematics by H. K. Das and Er. Rajnish Verma, S. Chand & CO. Pvt. Ltd., New Delhi.
3. A course in Engineering Mathematics (Vol I) by Dr. B. B. Singh, Synergy Knowledgeware, Mumbai.
4. Higher Engineering Mathematics by B. V. Ramana, Tata McGraw-Hill Publications, New Delhi.

Reference Books

1. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons, New York.
2. A Text Book of Engineering Mathematics by Peter O' Neil, Thomson Asia Pte Ltd. , Singapore.
3. Advanced Engineering Mathematics by C. R. Wylie & L. C. Barrett, Tata Mcgraw-Hill Publishing Company Ltd., New Delhi.

General Instructions:

1. The tutorial classes in Engineering Mathematics-I are to be conducted batchwise. Each class should be divided into three batches for the purpose.
2. The internal assessment of the students for 20 marks will be done based on assignments, surprise tests, quizzes, innovative approach to problem solving and percentage attendance.

3. The minimum number of assignments should be eight covering all topics.

BTBS102 Engineering Physics

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week Tutorial: 1 hrs/week	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

Objectives:

1. To provide a firm grounding in the basic physics principles and concept to resolve many Engineering and technological problems.

2. To understand and study the Physics principles behind the developments of Engineering materials.

Course Contents:

Unit I:
Oscillatio, Ultrasonics and Dielectric Materials: (06 Hrs) Free oscillation, damped oscillation, Forced oscillation and Resonance, differential wave equation, Ultrasonic waves, production of ultrasonics (Piezoelectric effect, Magnetostriction effect) and its applications.
Dielectric parameters (Dielectric constant, Electric displacement, Polarization & Polarizability), Types of polarization, temperature and frequency dependences of dielectric materials.

Unit II:
Optics, Fibre Optics and Laser: (06 Hrs)
Interference of light in thin film, wedge shaped film , Newton's rings, polarization of light, methods for production of polarized light(Reflection, Refraction& Double refraction), Huygen's theory of double refraction, Laurent's half shade Polarimeter, Principle and structure of optical fibre, acceptance angle, acceptance cone, numerical aperture.
Principle of laser, Einstein's coefficients, Types of laser – Ruby and He-Ne laser and their applications.

Unit III:
Electron Optics, Nuclear Physics and Quantum Mechanics: (06 Hrs)
Measurement of 'e/m' by Thomson's method, Determination of electronic charge by Millikan's oil drop method, Bainbridge mass spectrograph, GM counter, Heisenberg's uncertainty principle, Schrödinger's time dependent and time independent wave equations, physical significance of wave function.

Unit IV
Crystal Structure, X-rays and Electrodynamics:(06 Hrs)
Unit cell, Bravais lattice, cubic system, number of atoms per unit cell, coordination number, atomic radius, packing density, relation between lattice constant and density, lattice planes and Miller indices, Interplaner spacing for cubic system, Bragg's law, X-ray diffraction, Line and Continuous Spectrum of X-ray, Mosley's law. Introduction of Maxwell equations(no derivation), Electromagnetic wave in free space.

Unit V
Magnetic, Superconducting and Semiconducting materials: (06 Hrs)
Types of magnetic materials(Ferrimagnetic & Antiferromagnetic, Ferrites & Garnets), B-H curve, Classical free electron theory-electrical conductivity, resistivity and its temperature dependence, microscopic Ohm's law, Superconductivity, types of superconductors, Meissner effect and Applications. Band theory of solids, conductivity of semiconductors, Hall effect.

Expected Outcome:-

1. The student will be able to understand Engineering problems based on the principle of Oscillation, Ultrasonics, Optics, Laser, Fibre optics, Nuclear physics, Quantum mechanics.
2. The student will be able to understand Fundamental of Electrodynamics, Semiconductor, Dielectric, Magnetic and Superconducting materials which forms the base of many modern devices and technologies.

Text books:

1. Engineering Physics M.N. Avadhanulu and P.G. Kshirsagar. S.Chand and Company LTD.
2. Engineering Physics – Dr. L. N. Singh. Synergy Knowledgeware-Mumbai.
3. Engineering Physics - R.K. Gaur and S. L. Gupta. Dhanpat Rai Publications Pvt. Ltd.-New Delhi.
4. Fundamental of Physics - Halliday and Resnik. Willey Eastern Limited.

Reference books:

1. Introduction to Electrodynamics –David R. Griffiths.
2. Concept of Modern Physics – Arthur Beizer. Tata McGraw-Hill Publishing Company Limited.
3. Optics – Ajoy Ghatak.MacGraw Hill Education (India) Pvt. Ltd.
4. Science of Engineering Materials- C.M. Srivastava and C. Srinivasan. New Age International Pvt.Ltd.
5. Solid State Physics – A.J. Dekker. McMillan India –Limited.
6. The Feynman Lectures on Physics Vol I,II,III.
7. Introduction to solid state physics – Charles Kittel. John Willey and Sons

BTBES103 Engineering Graphics

Teaching Scheme:	Examination Scheme:
Lecture: 2 hrs/week	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks (Duration 04 hrs)

Course Contents:

Unit 1: Drawing standards and geometrical construction: 4hrs

Drawing standard SP: 46, Type of lines, lettering, dimensioning, scaling conventions. Geometrical construction: Dividing a given straight line into any number of equal parts, bisecting a given angle, drawing a regular polygon given one side, special methods of constructing a pentagon and a hexagon.

Unit 2: Orthographic Projections and Projections of Points: 4hrs

Introduction to orthographic projection, drawing of orthographic views of objects from their isometric views. Projection of points lying in four quadrants.

Unit 3: Projections of Straight Lines and Planes and their Traces : 4hrs

Projections of lines parallel and perpendicular to one or both planes, projections of lines inclined to one or both planes. Traces of lines. Projections of planes parallel and perpendicular to one or both planes, projection of planes inclined to one or both planes.

Unit 4: Projections of Solids 4hrs

Types of solids, projections of solids with axis perpendicular and parallel to HP and VP, solids with axis inclined to one or both the planes. Projections of spheres touching each other.

Unit 5: Sectioning of Solids, Isometric Projections 4hrs

Sectioning of solids: Section planes perpendicular to one plane and parallel or inclined to other plane. Isometric projections: Isometric scale, drawing of isometric projections from given orthographic views.

Reference/Text Books:

1. N. D. Bhatt, *Engineering Drawing*, Charotar Publishing House, 46th Edition, 2003.
2. K. V. Nataraajan, *A text book of Engineering Graphic*, Dhanalakshmi Publishers, Chennai, 2006.
3. K. Venugopal and V. Prabhu Raja, *Engineering Graphics*, New Age International (P) Ltd, 2008.
4. Dhananjay A. Jolhe, *Engineering Drawing with an Introduction to Autocad*, McGraw Hill Education, 2017.

BTHM104 Communication Skills

Teaching Scheme:	Examination Scheme:
Lecture: 2 hrs/week	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

Course Contents:

Unit 1: Communication and Communication Processes (04 hrs)
Introduction to Communication, Forms and functions of Communication, Barriers to Communication and overcoming them, Verbal and Non-verbal Communication
Reading: Introduction to Reading, Barriers to Reading, Types of Reading: Skimming, Scanning, Fast Reading, Strategies for Reading, Comprehension.
Listening : Importance of Listening, Types of Listening, Barriers to Listening.

Unit 2: Verbal & Non-verbal Communication (04 hrs)
Use of Language in Spoken Communication, Principles and Practice of Group Discussion, Public Speaking (Addressing Small Groups and Making Presentation), Interview Techniques, Appropriate Use of Non-verbal Communication, Presentation Skills, Extempore, Elocution.

Unit 3: Study of Sounds in English (02 hrs)
Introduction to phonetics, Study of Speech Organs, Study of Phonemic Script, Articulation of Different Sounds in English.

Unit 4: English Grammar (05 hrs)
Grammar: Forms of Tenses, Articles, Prepositions, Use of Auxiliaries and Modal Auxiliaries, Synonyms and Antonyms, Common Errors.

Unit 5: Writing Skills, Reading Skills & Listening Skills (04 hrs)
Features of Good Language, Difference between Technical Style and Literary Style, Writing Emails, Formal and Informal English, Technical Reports: Report Writing: Format, Structure and Types
Letter Writing: Types, Parts, Layouts, Letters and Applications, Use of Different Expressions and Style, Writing Job Application Letter and Resume.

Text book:

1. Mohd. Ashraf Rizvi, *Communication Skills for Engineers*, Tata McGraw Hill

Reference Books:

1) Sanjay Kumar, Pushp Lata, *Communication Skills*, Oxford University Press, 2016
2) Meenakshi Raman, Sangeeta Sharma, *Communication Skills*, Oxford University Press, 2017
3) Teri Kwal Gamble, Michael Gamble, *Communication Works*, Tata McGraw Hill Education, 2010
4) Anderson, Kenneth. Joan Maclean and Tossny Lynch. Study Speaking: A Course in Spoken English for Academic Purposes. Cambridge: CUP, 2004.
5) Aswalthapa, K. *Organisational Behaviour*, Himalayan Publication, Mumbai (1991).
6) Atreya N and Guha, *Effective Credit Management*, MMC School of Management, Mumbai (1994).
7) Balan,K.R. and Rayudu C.S., *Effective Communication*, Beacon New Delhi (1996).
8) Bellare, Nirmala. *Reading Strategies*. Vols. 1 and 2. New Delhi. Oxford University Press, 1998.
9) Bhasker, W. W. S & Prabhu, N. S.: *English through Reading*, Vols. 1 and 2. Macmillan, 1975.
10) Black, Sam. *Practical Public Relations*, E.L.B.S. London (1972).
11) Blass, Laurie, Kathy Block and Hannah Friesan. *Creating Meaning*. Oxford: OUP, 2007.
12) Bovee Courtland,L and Thrill, John V. *Business Communication*, Today McGraw Hill, New York, Taxman Publication (1989).

BTES105 Energy and Environment Engineering

Teaching Scheme:	Examination Scheme:
Lecture: 2 hrs/week	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

Course Contents:

Unit 1

Conventional Power Generation: Steam power station, Nuclear power plant – Gas turbine power plant- Hydro power station: Schematic arrangement, advantages and disadvantages, Thermo electric and thermionic generators, Environmental aspects for selecting the sites and locations of power plants.[**4 hrs]**

Unit 2

Renewable Power Generation: Solar, Wind, Biogas and Biomass, Ocean Thermal energy conversion (OTEC), Tidal, Fuel cell, Magneto Hydro Dynamics (MHD): Schematic arrangement, advantages and disadvantages.[**4 hrs]**

Unit 3

Energy conservation: Scope for energy conservation and its benefits Energy conservation Principle – Maximum energy efficiency, Maximum cost effectiveness, Methods and techniques of energy conservation in ventilation and air conditioners, compressors, pumps, fans and blowers, Energy conservation in electric furnaces, ovens and boilers., lighting techniques.[**4 hrs]**

Unit 4

Air Pollution: Environment and Human health - Air pollution: sources- effects- control measures - Particulate emission, air quality standards, and measurement of air pollution.[**4 hrs]**

Unit 5

Water Pollution: Water pollution- effects- control measures- Noise pollution –effects and control measures, Disposal of solid wastes, Bio-medical wastes-Thermal pollution – Soil pollution -Nuclear hazard.[**4 hrs]**

Reference/Text Books:

1. A Chakrabarti, M. L Soni, P. V. Gupta, U. S. Bhatnagar, A Text book of Power System Engineering, Dhanpat Rai Publication.
2. Rai. G. D., Non Conventional Energy Sources, Khanna Publishers, Delhi, 2006.
3. Rao S., Parulekar B.B., Energy Technology-Non conventional, Renewable And Conventional, Khanna Publishers, Delhi, 2005.
4. Glynn Henry J., Gary W. Heinke, Environmental Science and Engineering, Pearson Education, Inc, 2004.
5. J. M. Fowler, Energy and the Environment, McGraw-Hill, 2 nd Edition, 1984.
6. Gilbert M. Masters, Introduction to Environmental Engineering and Science, 2nd Edition, Prentice Hall, 2003.

BTES106 Basic Civil and Mechanical Engineering

Teaching Scheme:	Examination Scheme:
Lecture: 2 hrs/week	Internal Assessment: 50 Marks (Audit)

Course Contents:

Part I Basic Civil Engineering

Unit 1: Introduction to civil engineering (4hrs)

Various Branches, role of civil engineer in various construction activities, basic engineering properties and uses of materials: earth, bricks, timber, stones, sand, aggregates, cement, mortar, concrete, steel, bitumen, glass, FRP, composite materials.

Unit 2: Building Components & Building Planning (4hrs)

Foundation and superstructure, functions of foundation, types of shallow and deep foundations, suitability in different situation, plinth, walls, lintels, beams, columns, slabs, roofs, staircases, floors, doors, windows, sills, Study of Building plans, ventilation, basics of plumbing and sanitation

Unit 3: Surveying (4hrs)

Principles of survey, elements of distance and angular measurements, plotting of area, base line and offsets, introduction to Plane table surveying, introduction to levelling, concept of bench marks, reduced level, contours

Part II Basic Mechanical Engineering

Unit 4: Introduction to Mechanical Engineering, Introduction to Laws of Thermodynamics with simple examples pertaining to respective branches, IC Engines: Classification, Applications, Basic terminology, 2 and 4 stroke IC engine working principle, Power Plant: Types of Power plant; Gas power plant, Thermal power plant, Nuclear power plant, Automobiles: Basic definitions and objective (**4 hrs)**

Unit 5: Design Basics, Machine and Mechanisms, Factor of safety, Engineering Materials: types and applications, basics of Fasteners Machining and Machinability, Introduction to Lathe machine, Drilling machine, Milling machine, basics of machining processes such as turning, drilling and milling, Introduction to casting (**4 hrs)**

Text Books

1. Anurag Kandya, “Elements of Civil Engineering”, Charotar Publishing, Anand
2. M. G. Shah, C. M. Kale, and S. Y. Patki, “Building Drawing”, Tata McGraw Hill
3. Sushil Kumar, “Building Construction”, Standard Publishers Distributors
4. M. S. Palani Gamy, “Basic Civil Engineering”, Tata Mc-Graw Hill Publication
5. Kanetkar T. P. and Kulkarni S. V., “Surveying and Levelling”, Vols. I, II and III, Vidyarthi Gruh Prakashan, Pune
6. B. C. Punmia, “Surveying”, Vol.- I, Vol.-II, Vol.-III, Laxmi Publications
7. G. K. Hiraskar, “Basic Civil Engineering”, Dhanpat Rai Publications
8. Gopi Satheesh, “Basic Civil Engineering”, Pearson Education
9. P. K. Nag “Engineering Thermodynamics”, Tata McGraw Hill, New Delhi 3rd ed. 2005
10. A. Ghosh, A K Malik, “Theory of Mechanisms and Machines”, Affiliated East West Press Pvt. Ltd. New Delhi.
11. Serope Kalpakaji and Steven R Schimd “ Amanufacturing Engineering and Techology” Addision Wsley Laongman India 6th Edition 2009
12. V. B. Bhandari, “ Deisgn of Machine Elements”, Tata McGraw Hill Publications, New Delhi.

BTBS107L Engineering Physics Lab

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Internal Assessment: 60 Marks External Exam: 40 Marks

Course Contents:

At least 10 experiments should be performed from the following list.

1. Newton's rings - Determination of radius of curvature of Plano convex lens / wavelength of light
2. Wedge Shaped film - Determination of thickness of thin wire
3. Half shade Polarimeter - Determination of specific rotation of optically active material
4. Laser - Determination of wavelength of He-Ne laser light
5. Magnetron Tube - Determination of 'e/m' of electron
6. G.M. Counter - Determination of operating voltage of G.M. tube
7. Crystal Plane – Study of planes with the help of models related Miller Indices
8. Hall Effect - Determination of Hall Coefficient
9. Four Probe Method - Determination of resistivity of semiconductor
10. Measurement of Band gap energy of Semiconductors
11. Study of I-V characteristics of P-N junction diode
12. Experiment on fibre optics
13. Ultrasonics Interferometer
14. B-H Curve Experiment
15. Susceptiblity measurement experiment

BTES108L Engineering Graphics Lab

Practical Scheme:	**Examination Scheme:**
Practical: 3 hrs/batch	Internal Assessment: 60 Marks External Exam: 40 Marks

Course Contents:

List of Practical:

1. Lines, lettering and dimensioning.
2. Geometrical Constructions. (AutoCAD)
3. Orthographic projections. (AutoCAD)
4. Projections of points. (AutoCAD)
5. Projections of straight lines. (AutoCAD)
6. Projections of planes.
7. Projections of solids.
8. Section of solids.
9. Isometric Projections. (AutoCAD)

BTHM109L Communication Skills Lab

Practical Scheme:	Examination Scheme:
Practical: 2 hrs/batch	Internal Assessment: 60 Marks External Exam: 40 Marks

Course Contents:

List of Practicals (Any 10 PR sessions can be conducted)

1) How to introduce oneself? (02 hrs)
2) Introduction to Phonemic symbols (02 hrs)
3) Articulation of sounds in English with proper manner (02 hrs)
4) Practice and exercises on articulation of sounds (02 hrs)
5) Read Pronunciations/transcriptions from the dictionary (02 hrs)
6) Practice and exercises on pronunciations of words (02 hrs)
7) Introduction to stress and intonation (02 hrs)
8) Rapid reading sessions (02 hrs)
9) Know your friend (02 hrs)
10) How to introduce yourself (02 hrs)
11) Extempore (02 hrs)
12) Group discussion (02 hrs)
13) Participating in a debate (02 hrs)
14) Presentation techniques (02 hrs)
15) Interview techniques (02 hrs)

SEMESTER II
BTBS201 Engineering Mathematics II

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week Tutorial: 1 hrs/week	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

Course Content:

Unit 1: Complex Numbers
Definition and geometrical representation ; De-Moivre's theorem(without proof) ; Roots of complex numbers by using De-Moivre's theorem ; Circular functions of complex variable – definition ; Hyperbolic functions ; Relations between circular and hyperbolic functions ; Real and imaginary parts of circular and hyperbolic functions ; Logarithm of Complex quantities. **[09 Hours]**

Unit 2: Ordinary Differential Equations of First Order and First Degree and Their Applications
Linear equations; Reducible to linear equations (Bernoulli's equation); Exact differential equations; Equations reducible to exact equations ; Applications to orthogonal trajectories , mechanical systems and electrical systems. **[09 Hours]**

Unit 3: Higher Order Linear Differential Equations with Constant Coefficients
Introductory remarks - complementary function, particular integral; Rules for finding complementary functions and particular integrals; Method of variation of parameters; Cauchy's homogeneous and Legendre's linear equations. **[09 Hours]**

Unit 4: Fourier series
Introductory remarks- Euler's formulae ; Conditions for Fourier series expansion - Dirichlet's conditions ; Functions having points of discontinuity ; Change of interval ; Odd and even functions - expansions of odd and even periodic functions ; Half -range series. **[09 Hours]**

Unit 5: Vector Calculus
Scalar and vector fields: Gradient, divergence and curl; Solenoidal and irrotational vector fields; Vector identities (statement without proofs) ; Green's lemma , Gauss' divergence theorem and Stokes' theorem (without proofs) . **[09 Hours]**

Text Books

1. Higher Engineering Mathematics by B. S. Grewal, Khanna Publishers, New Delhi.
2. Higher Engineering Mathematics by H. K. Das and Er. Rajnish Verma, S. Chand & CO. Pvt. Ltd., New Delhi.
3. A course in Engineering Mathematics (Vol II) by Dr. B. B. Singh, Synergy Knowledgeware, Mumbai.
4. Higher Engineering Mathematics by B. V. Ramana, Tata McGraw-Hill Publications, New Delhi.

Reference Books

1. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons, New York.
2. A Text Book of Engineering Mathematics by Peter O' Neil, Thomson Asia Pte Ltd. , Singapore.
3. Advanced Engineering Mathematics by C. R. Wylie & L. C. Barrett, Tata Mcgraw-Hill Publishing Company Ltd., New Delhi.

General Instructions:

1. The tutorial classes in Engineering Mathematics-II are to be conducted batchwise. Each class should be divided into three batches for the purpose.
2. The internal assessment of the students for 20 marks will be done based on assignments, surprise tests, quizzes, innovative approach to problem solving and percentage attendance.
3. The minimum number of assignments should be eight covering all topics.

CHM202 Engineering Chemistry

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hrs/week	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

Course Content:

ENGINEERING CHEMISTRY

Unit 1: Water Treatment **(7L)**

Introduction , Hard and Soft water, Disadvantages of hard water –In Domestic use, In Industrial use, Softening of water – Zeolite process, Ion exchange process, Hot Lime –Soda process, water characteristics- Hardness and its determination by EDTA method, Dissolved oxygen (DO) and its determination by Winkler's method.

Unit 2: Phase Rule **(6L)**

Phase Rule, statement, Explanation of the terms – Phase, Component, Degrees of freedom. One component system–Water and Sulphur, Reduced Phase rule equation, Two component alloy system- Phase diagram of Silver- Lead alloy system.

Unit 3: Corrosion and its Control **(7L)**

Introduction, Fundamental reason of corrosion, Electrochemical Corrosion, Mechanism of Electrochemical corrosion: a) Hydrogen Evolution Mechanism b) Absorption of Oxygen Mechanism, Direct Chemical Corrosion(Dry corrosion), Factors affecting the rate of corrosion, Methods to minimise the rate of corrosion: Proper designing , Cathodic and Anodic protection method.

Unit 4: Fuels and Lubricants **(7L)**

Fuels: Introduction, Classification of fuel, Calorific value of a fuel, Characteristics of a good fuel, solid fuel- Coal and Various types of Coal, Analysis of coal- Proximate and Ultimate analysis, Liquid fuel- Refining of Petroleum.

Lubricants: Introduction, Classification of lubricants - Solid, Semi–solid and Liquid Lubricants, Properties of lubricants: Physical properties – Viscosity, Viscosity index, Surface tension, Flash point and Fire point. Chemical properties - Acidity, Saponification.

Unit 5: Electrochemistry **(7L)**

Introduction –**Basic Concepts:** Definition and units of Ohm's Law, Specific Resistance, Specific Conductance, Equivalent Conductance, Molecular Conductance. Method of conductance measurement by Wheatstone bridge method, Cell constant, Conductometric titrations, Glass electrode, Nernst equation and its application for the calculation of half-cell potential, Fuel cell(H_2-O_2 fuel cell), Advantages of fuel cell, Ostwald's theory of acid- base indicator.

Text books:

1. Jain P.C & Jain Monica, Engineering Chemistry, Dhanpat Rai & Sons, Delhi, 1992.
2. Bhal & Tuli, Text book of Physical Chemistry, S. Chand & Company, New Delhi.
3. Shikha Agarwal, Engineering Chemistry- Fundamentals and applications, Cambridge Publishers - 2015.

Reference books:

1. Barrow G.M., Physical Chemistry, McGraw-Hill Publication, New Delhi.
2. O. G. Palanna , Engineering Chemistry, Tata McGraw-Hill Publication, New Delhi.
3. WILEY, Engineering Chemistry, Wiley India, New Delhi 2014.
4. S.S.Dara, Engineering Chemistry,McGraw Hill Publication, New Delhi.

BTES203 Engineering Mechanics

Teaching Scheme:	Examination Scheme:
Lecture: 2 hrs/week Tutorial: 1 hrs/week	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

Course Content:

Unit 1: Basic Concepts (7 Lectures)
Objectives of Engineering Analysis and Design, Idealization of Engineering Problems, Simplification of real 3D problems to 2-D and 1-D domain,Basis of Assumptions, types of supports, types of load, free body diagram, Laws of Motion, Fundamental principles, Resolution and composition of a forces, Resultant, couple, moment, Varignon's theorem, force systems, Centroid of composite shapes, moment of inertia of planer sectionsand radius of gyration

Unit 2: Equilibrium (7 Lectures)
Static equilibrium, analytical and graphical conditions of equilibrium, Lami's theorem, equilibrium of coplanar concurrent forces, coplanar non concurrent forces, parallel forces,beams reactionsSimple trusses (plane and space), method of joints for plane trusses, method of sections for plane trusses **Friction:**Coulomb law, friction angles, wedge friction, sliding friction and rolling resistance

Module3: Kinematics (7 Lectures)
Types of motions, kinematics of particles, rectilinear motion, constant and variable acceleration, relative motion, motion under gravity, study of motion diagrams, angular motion, tangential and radial acceleration, projectile motion, kinematics of rigid bodies, concept of instantaneous center of rotation, concept of relative velocity.

Module4: Kinetics (6 Lectures)
Mass moment of inertia, kinetics of particle, D'Alembert's principle:applications in linear motion, kinetics of rigid bodies, applications in translation, applications in fixed axis rotation

Module5: Work, Power, Energy (6 Lectures)
Principle of virtual work, virtual displacements for particle and rigid bodies, work done by a force, spring, potential energy, kinetic energy of linear motion and rotation, work energy equation, conservation of energy, power, impulse momentum principle, collision of elastic bodies.

Text Books

1. S. Timoshenko, D. H. Young, "Engineering Mechanics", McGraw Hill, 1995.
2. Tayal A. K., "Engineering Mechanics", Umesh Publications, 2010.
3. Bhavikatti S. S., Rajashekarappa K. G., "Engineering Mechanics", New Age International Publications, 2nd Edition.
4. Beer, Johnston, "Vector Mechanics for Engineers", Vol. 1: Statics and Vol. 2: Dynamics, McGraw Hill Company Publication, 7th edition, 1995.
5. Irving H. Shames, "Engineering Mechanics - Statics and Dynamics", Pearson Educations, Fourth edition, 2003.
6. McLean, Nelson, "Engineering Mechanics", Schaum's outline series, McGraw Hill Book Company, N. Delhi, Publication.
7. Singer F. L., "Engineering Mechanics - Statics & Dynamics", Harper and Row Pub. York.
8. Khurmi R. S., "Engineering Mechanics", S. Chand Publications, N. Delhi

BTES204 Computer Programming

Teaching Scheme:	Examination Scheme:
Lecture: 3hrs/week	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

Course Content:

Unit 1

Process of programming: Editing, Compiling, Error Checking, executing, testing and debugging of programs. IDE commands. Eclipse for C Program development, Flowcharts, Algorithms. **(4 Lectures)**

Unit 2

Types, Operators and Expressions: Variable names, Data types, sizes, constants, declarations, arithmetic operators, relational and logical operators, type conversions, increment and decrement operators, bitwise operators, assignment operators and expressions, conditional expressions precedence and order of evaluation. **(4 Lectures)**

Unit 3

Control Flow: Statements and Blocks. If-else, else-if switch Loops while and for, do-while break and continue goto and Labels. Functions and Program Structure: Basic of functions, functions returning nonintegers external variables scope rules. **4 Lectures)**

Unit 4

Arrays in C: Initializing arrays, Initializing character arrays, multidimensional arrays. **(4 Lectures)**

Unit 5

Structures C: Basics of structures, structures and functions arrays of structures. **(4 Lectures)**

Pointer in C. Pointers to integers, characters, floats, arrays, structures.

Special Note: Topic of Pointers in C is only for lab exercises and not for end semester examinations.

Reference/Text Books:

1. Brain W. Kernighan & Dennis Ritchie, The C Programming Language, Prentice Hall, 2 nd Edition, 1988.
2. R. S. Bichkar, Programming with C, Orient Blackswan, 1 st Edition, 2012.
3. Herbert Schildit, C the Complete Reference, McGraw-Hill Publication, 2000.
4. Balguruswamy, Programming in C, PHI.
5. Yashwant Kanitkar, Let Us C, PHI

BTES205 Basic Electrical and Electronics Engineering

Teaching Scheme:	Examination Scheme:
Lecture: 2 hrs/week	Internal Assessment: 50 Marks (Audit)

Course Content:

Unit 1 **(4 Lectures)**

Elementary Electrical Concepts:

Fundamental of Electrical system Potential difference, Ohm's law, Effect of temperature on resister, resistance temperature coefficient, Electrical wiring system: Study of different wire gauges and their applications in domestic and industry. Energy Resources and Utilization: Conventional and nonconventional energy resources; Introduction to electrical energy generation from different resources, transmission, distribution and utilization, Advantages & Disadvantages of AC & DC transmission. Concept of Supply Demand, Power Factor, Need of unity factor.

Unit 2 **(4 Lectures)**

Measurement of Electrical Quantities:

Measurement of Voltage, Current, and Power; Measurement of 3 phase power; Study of Energy meters. Study of Electrical Storage devices: Batteries such as Nickel-cadmium (NiCd), Lithium- ion (Li-ion), Lithium Polymer (Li-pol.) batteries. Study of circuit breakers & Actuators (MCB & MPCB, Power Contactors & Aux contactors, Electro-Mechanical & Solid state Relays)

Unit 3 **(4 Lectures)**

Diodes and Circuits:

The P-N Junction Diode, V-I characteristics, Diode as Rectifier, specifications of Rectifier Diodes, Half Wave, Full wave, Bridge rectifiers, Equations for I_{DC} V_{DC} V_{RMS}, I_{RMS}, Efficiency and Ripple Factor for each configuration. Filters: Capacitor Filter, Choke Input Filter, Capacitor Input Filter(Π Filter), Zener Diode, Characteristics, Specifications, Zener Voltage Regulator, Types of Diodes: LED, Photodiode

Unit 4 **(4 Lectures)**

Semiconductor Devices and Applications:

Transistors: Introduction, Classification, CE, CB, and CC configurations, α, β, concept of gain and bandwidth. Operation of BJT in cut-off, saturation and active regions (DC analysis). BJT as an amplifier, biasing techniques of BJT, BJT as a switch.

Introduction to Digital Electronics: Number System, Basic logic Gates, Universal Gates, Boolean Postulates, De-Morgan Theorems

Reference/Text Books:

1. V.N. Mittal and Arvind Mittal, Basic Electrical Engineering, McGraw-Hill Publication.
2. Brijesh Iyer and S. L. Nalbalwar, A Text book of Basic Electronics, Synergy Knowledgeware Mumbai, 2017. ISBN:978-93-8335-246-3
3. Vincent DelToro, Electrical engineering Fundamentals, PHI Publication, 2nd Edition, 2011.
4. Boylstad, Electronics Devices and Circuits Theory, Pearson Education.
5. Edward Hughes, Electrical Technology, Pearson Education.
6. D. P. Kothari and Nagrath, Theory and Problems in Electrical Engineering, PHI Publication, 2011.
7. B. L. Theraja, Basic Electronics, S. Chand Limited, 2007.
8. Millman Halkias, Integrated Electronics-Analog and Digital Circuits and Systems, McGraw-Hill Publication, 2000.
9. Donald Neaman, Electronic Circuit Analysis and Design, McGraw-Hill Publication, 3rd Edition.
10. Donald Neaman, Electronic Circuit Analysis and Design, McGraw-Hill Publication, 3rd Edition.
11. Printed Circuit Boards Design & Technology, Walter C. Bosshart, McGraw-Hill Publication.

Note: Students are advised to use internet resources whenever required

BTES206L Workshop Practice

Teaching Scheme:	Examination Scheme:
Practical: 4 hrs/batch	Internal Assessment: 60 Marks External Exam: 40 Marks

Instruction to Students:
Each student is required to maintain a „workshop diary" consisting of drawing / sketches of the jobs and a brief description of tools, equipment, and procedure used for doing the job.

List of Practical:

1. Wood sizing exercises in planning, marking, sawing, chiseling and grooving to make half lap joint and cross lap joint.
2. A job involving cutting, filing to saw cut, filing all sides and faces, corner rounding, drilling and tapping on M. S. plates.
3. A job on use of plumbing tools and preparation of plumbing line involving fixing of water tap and use of elbow, tee, union and coupling, etc.
4. Making a small parts using GI sheet involving development, marking, cutting, bending, brazing and soldering operations- i)Tray ii) Funnel and similar articles.
5. Exercise in Arc welding (MMAW) to make a square butt joint.
6. Exercise in Resistance (Spot) welding to make a lap joint.
7. A job using power operated tools related to sheet metal work, Welding, Fitting, Plumbing, Carpentry and pattern making.
8. A job on turning of a Mild Steel cylindrical job using center lathe.

Contents:

a) **Carpentry:** Technical Terms related to wood working, Types of wood, Joining materials, Types of joints - Mortise and Tenon, Dovetail, Half Lap, etc., Methods of preparation and applications, Wood working lathe, safety precautions.
b) **Welding:** Arc welding - welding joints, edge preparation, welding tools and equipment, Gas welding - types of flames, tools and equipment, Resistance welding - Spot welding, joint preparation, tools and equipment, safety precautions.
c) **Fitting and Plumbing:** Fitting operation like chipping, filing, right angle, marking, drilling, tapping etc., Fitting hand tools like vices, cold chisel, etc. Drilling machine and its operation, Different types of pipes, joints, taps, fixtures and accessories used in plumbing, safety precautions.
d) **Sheet Metal Work:** Simple development and cutting, bending, Beading, Flanging, Lancing and shearing of sheet metal, Sheet metal machines - Bending Machine, Guillotine shear, Sheet metal joints, Fluxes and their use.
e) **Machine shop**: Lathe machine, types of lathes, major parts, cutting tool, turning operations, safety precautions

Reference/Text Books:

1. K. C. John, Mechanical Workshop Practice, Prentice Hall Publication, New Delhi, 2010.
2. Hazra and Chaudhary, Workshop Technology-I, Media promoters & Publisher private limited.

BTBS207L Engineering Chemistry Lab

Practical Scheme:	Examination Scheme:
Practical: 2 hrs/batch	Internal Assessment: 60 Marks External Exam: 40 Marks

List of Experiments: (Perform any 8 - 10 Experiments)

1. Determination of Hardness of water sample by EDTA method.
2. Determination of Chloride content in water sample by precipitation titration method.
3. Determination of Dissolved Oxygen in water by Iodometric method.
4. Determination of Percent purity of Bleaching Powder.
5. pH – metric Titration (Acid Base titration)
6. Conductometric Titration (Acid Base titration)
7. Surface tension
8. Viscosity
9. To determine Acidity of water sample.
10. To determine Calorific value of a fuel.
11. Determination of Acid value of an oil sample.
12. Determination of Saponification value of an oil sample.
13. Experiment on water treatment by using Ion exchange resins.
14. To find out P-T curve diagram of steam.
15. To determine Alkalinity water sample.
16. Determination of rate of corrosion of metal.

Reference Books:

1. Systematic experiments in Chemistry, A. Sethi, New Age International Publication, New Delhi.
2. Practical Inorganic Chemistry, A. I. Vogel, ELBS Pub.
3. Practical in Engineering Chemistry, S. S. Dara.

BTES208L Engineering Mechanics Laboratory

Practical Scheme:	Examination Scheme:
Practical: 2 hrs/batch	Internal Assessment: 60 Marks External Exam: 40 Marks

Students are expected to satisfactorily complete any ten experiments listed below.

List of Practical's/Experiments/Assignments

1. Polygon law of coplanar forces.
2. Centroid of irregular shaped bodies.
3. Bell crank lever.
4. Support reaction for beam.
5. Problems on beam reaction by graphics statics method.
6. Simple / compound pendulum.
7. Inclined plane (to determine coefficient of friction).
8. Collision of elastic bodies (Law of conservation of momentum).
9. Moment of Inertia of fly wheel.
10. Verification of law of Machine using Screw jack
11. Verification of law of Machine using Worm and Worm Wheel
12. Verification of law of Machine using Single and Double Gear Crab.
13. Assignment based on graphics statics solutions
14. Application of Spreadsheet Program for conceptslike law of moments, beam reactions, problems in kinematics, etc.
15. Any other innovative experiment relevant to Engineering Mechanics.

Semester III

Engineering Mathematics-III

BTBS301	BSC 7	Engineering Mathematics-III	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	
CO7	
CO8	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												
CO7												
CO8												

Course Contents:

Unit 1: Laplace Transform

Definition – conditions for existence ; Transforms of elementary functions ; Properties of Laplace transforms - Linearity property, first shifting property, second shifting property, transforms of functions multiplied by t^n, scale change property, transforms of functions divided by t, transforms of integral of functions, transforms of derivatives ; Evaluation of integrals by using Laplace transform ; Transforms of some special functions- periodic function, Heaviside-unit step function, Dirac delta function.

[09 Hours]

Unit 2: Inverse Laplace Transform

Introductory remarks ; Inverse transforms of some elementary functions ; General methods of finding inverse transforms ; Partial fraction method and Convolution Theorem for finding inverse Laplace transforms ; Applications to find the solutions of linear differential equations and simultaneous linear differential equations with constant coefficients.

[09 Hours]

Unit 3: Fourier Transform

Definitions – integral transforms ; Fourier integral theorem (without proof) ; Fourier sine and cosine integrals ; Complex form of Fourier integrals ; Fourier sine and cosine transforms ; Properties of Fourier transforms ; Parseval's identity for Fourier Transforms.

[09 Hours]

Unit 4: Partial Differential Equations and Their Applications

Formation of Partial differential equations by eliminating arbitrary constants and functions; Equations solvable by direct integration; Linear equations of first order (Lagrange's linear equations); Method of separation of variables – applications to find solutions of one dimensional heat flow equation $\left(\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}\right)$, and one dimensional wave equation (i.e.$\frac{\partial^2 y}{\partial t^2} = c^2 \frac{\partial^2 y}{\partial x^2}$).

[09 Hours]

Unit 5: Functions of Complex Variables

Analytic functions; Cauchy- Riemann equations in Cartesian and polar forms; Harmonic functions in Cartesian form; Cauchy's integral theorem; Cauchy's integral formula; Residues; Cauchy's residue theorem (All theorems without proofs). **[09 Hours]**

Text Books

1. Higher Engineering Mathematics by B. S. Grewal, Khanna Publishers, New Delhi.
2. Higher Engineering Mathematics by H. K. Das and Er. RajnishVerma, S. Chand & CO. Pvt. Ltd., New Delhi.
3. A course in Engineering Mathematics (Vol III) by Dr. B. B. Singh, Synergy Knowledgeware, Mumbai.
4. Higher Engineering Mathematics by B. V. Ramana, Tata McGraw-Hill Publications, New Delhi.

Reference Books

1. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons, New York.
2. A Text Book of Engineering Mathematics by Peter O' Neil, Thomson Asia Pte Ltd. , Singapore.
3. Advanced Engineering Mathematics by C. R. Wylie & L. C. Barrett, Tata Mcgraw-Hill Publishing Company Ltd.,
   New Delhi.
4. Integral Transforms and their Engineering Applications by Dr. B. B. Singh, Synergy Knowledgeware, Mumbai.

5. Integral Transforms by I. N. Sneddon, Tata McGraw-Hill, New York.

General Instructions:

1. The tutorial classes in Engineering Mathematics-III are to be conducted batchwise. Each class should be divided into three batches for the purpose.
2. The internal assessment of the students for 20 marks will be done based on assignments, surprise tests, quizzes, innovative approach to problem solving and percentage attendance.
3. The minimum number of assignments should be eight covering all topics.

Fluid Mechanics

BTMC302	PCC 1	Fluid Mechanics	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Define fluid, define and calculate various properties of fluid
CO2	Calculate hydrostatic forces on the plane and curved surfaces and explain stability of floating bodies
CO3	Explain various types of flow. Calculate acceleration of fluid particles
CO4	Apply Bernoulli's equation and Navier-Stokes equation to simple problems in fluid mechanics
CO5	Explain laminar and turbulent flows on flat plates and through pipes
CO6	Explain and use dimensional analysis to simple problems in fluid mechanics
CO7	Understand boundary layer, drag and lift

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1							1
CO2	3	3	1	1	1							1
CO3	3	3	1	1	1							1
CO4	3	3										1
CO5	3	3										1
CO6	2	3										1
CO7	2	3										1

Course Contents:

Unit 1: Basics [06 Hours]

Definition of fluid, fluid properties such as viscosity, vapour pressure, compressibility, surface tension, capillarity, Mach number etc., pressure at a point in the static mass of fluid, variation of pressure, Pascal's law, pressure measurement by simple and differential manometers using manometric expression.

Unit 2: Fluid Statics [06 Hours]

Hydrostatic forces on the plane and curved surfaces, centre of pressure, Buoyancy, centre of buoyancy, stability of floating bodies, metacentre and metacentric height its application in shipping.

Unit 3: Fluid Kinematics [08 Hours]
Velocity of fluid particle, types of fluid flow, description of flow, continuity equation, Coordinate freeform, acceleration of fluid particle, rotational and irrotational flow, Laplace's equation in velocity potential and Poisson's equation in stream function, flownet.

Unit 4: Fluid Dynamics [10 Hours]
a) Introduction to boundary layer theory and its analysis.
b) Momentum equation, development of Euler's equation, Introduction to Navier-Stokes equation, Integration of Euler's equation to obtain Bernoulli's equation, Bernoulli's theorem, Application of Bernoulli's theorem such as venturimeter, orificemeter, rectangular and triangular notch, pitot tube, orifices, etc.
c) Laminar Flow- Flow through circular pipe, between parallel plates, Power absorbed in viscous flow in bearings, loss of head due to friction in viscous flow.

Unit 5: Turbulent Flow and Dimensional Analysis [10 Hours]
a) Turbulent Flow**:** Reynolds's experiment, frictional loss in pipe flow, shear stress in turbulent flow, major and minor losses, HGL and TEL, flow through series and parallel pipes.

b) Dimensional Analysis:Dimensional homogeneity, Raleigh's method, Buckingham's theorem, Model analysis, similarity laws and dimensionless numbers.
d) Forces on Submerged bodies:Drag, lift, Drag on cylinder, Development of lift in cylinder.

Texts:
1. P. N. Modi, S. M. Seth, "Fluid Mechanics and Hydraulic Machinery", Standard Book House, 10^{th} edition,1991.
2. Robert W. Fox, Alan T. McDonald, "Introduction to Fluid Mechanics", John Wile and Sons, 5^{th}edition.

References:
1. V. L. Streeter, K. W. Bedfordand E. B. Wylie, "Fluid Dynamics", Tata McGraw-Hill, 9^{th}edition, 1998.
2. S. K. Som, G.Biswas, " Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw Hill, 2^{nd}edition, 2003.

Engineering Thermodynamics & Heat Transfer

BTAC303	Thermodynamics& Heat Transfer	PCC 2	3L-1T-0P	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial:1 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Course Contents:

Unit 1: Elementary Thermodynamics[08 Hours]

Basics of Thermodynamics, Ideal gas Laws, First Law of Thermodynamics, Steady Flow Energy Equation, Carnot Cycle, reverse Carnot Cycle, Second Law of Thermodynamics, Concept of refrigeration, Heat Pump and Heat Engine.

Unit 2: Vapor Power Cycles[08 Hours]

Vapour power cycles Steam Generation and its properties, Measurement of dryness fraction, Carnot Cycle, Application of Gas laws to vapour processes. Ideal Rankine Cycle, Calculation of Thermal Efficiency, Specific Steam Consumption, Work ratio.

Steam Turbines: Types, construction, working, compounding, velocity diagram, & diagram efficiency (No numerical).

Unit 3: Fuels and Fundamentals of Combustion[08 Hours]

Solid, Liquid and gaseous fuels, Combustion equations, analysis of product of combustion, gravimetric and volumetric analysis, theoretical air, excess air and exhaust gas produced.

Unit 4: I. C. Engines[08 Hours]

Air standard Otto, Diesel cycles(Elementary Numerical treatment), classifications of ICE and systems of I.C. engines such as fuel supply system for SI & CI engines, ignition system, cooling system, lubrication system, Performance of IC Engine –Indicated power, Brake power, Thermal efficiency, Specific fuel consumption(Elementary Numerical).

Unit 5: Heat Transfer[08 Hours]

Introduction and Basic Concepts of Conduction: Application areas of heat transfer in manufacturing and machine tools, Modes and Laws of heat transfer, thermal conductivity, thermal diffusivity, Heat conduction in plane wall, composite slab, composite cylinder, composite sphere, electrical analogy, concept of thermal resistance, overall heat transfer coefficient, conduction, critical radius of insulation for cylinders and spheres, economic

thickness of insulation. (Elementary numerical)

Fundamentals of convection: Concept Laminar and turbulent flow, Reynold Number, Prandlt number, Grashoff number, Nusselt Number. Mechanism of natural and forced convection, local and average heat transfer coefficient, concept of velocity & thermal boundary layers.

Fundamentals of Radiation: Fundamental concepts of radiation, different laws of radiation, Concept of: shape factor, radiation between two black and diffuse gray surfaces and radiation shields. (No numerical)

Texts:

1. R.K. Rajput, "Thermal Engineering", Laxmi Publications.
2. R. S. Khurmi and Gupta, "Thermal Engineering", S. Chand Publication.

References:

1. S.P. Sukhatme, "Heat Transfer", Orient Longman.
2. Y.A. Cengel, "Thermodynamics – an Engineering approach" Tata McGraw Hill.
3. Eastop, A. Mc'conkey, "Applied Thermodynamics", Pearson Publishers.
4. Holman J.P., "Heat Transfer", Tata McGraw Hill.

Material Science and Metallurgy

BTMES304	ESC10	Materials Science and Metallurgy	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Study various crystal structures of materials
CO2	Understand mechanical properties of materials and calculations of same using appropriate equations
CO3	Evaluate phase diagrams of various materials
CO4	Suggest appropriate heat treatment process for a given application
CO5	Prepare samples of different materials for metallography
CO6	Recommend appropriate NDT technique for a given application

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1									
CO2	3	2	2	3	2							
CO3	2	1	2	1	1							
CO4	1	2	2	1	2	1	2	1	1	1		
CO5	1	1	1	3	2		1		1			
CO6	1	1	2	2	2	1	2		1	1		

Course Contents:

Unit 1: Fundamentals

a) Structure of Materials [15 Hours]

Crystal structures, indexing of lattice planes, Indexing of lattice directions, Imperfections in crystals-point defects, line defects, surface and bulk defects, Mechanism of plastic deformation, deformation of single crystal by slip, plastic deformation of polycrystalline materials.

b) Mechanical Properties and their Testing

Tensile test, engineering stress-strain curve, true stress-strain curve, types of stress-strain curves, compression test, bend test, torsion test, formability, hardness testing, different hardness tests-Vickers, Rockwell, Brinnel, Impact test, fatigue test, creep test.

Unit 2: Equilibrium Diagrams [09 Hours]
Definitions of terms, rules of solid-solubility, Gibb's phase rule, solidification of a pure metal, plotting of equilibrium diagrams, lever rule, Iron-iron carbide equilibrium diagram, critical temperatures, solidification and microstructure of slowly cooled steels, non-equilibrium cooling of steels, property variation with microstructures, classification and application of steels, specification of steels, transformation products of austenite, TTT diagram, critical cooling rate, CCT diagram.

Unit 3: Heat Treatment [07 Hours]
Heat treatment of steels, cooling media, annealing processes, normalizing, hardening, tempering, quenching and hardenability, surface hardening processes-nitriding, carbo-nitriding, flame hardening, induction hardening.

Unit 4: Metallography [08 Hours]
Microscopy, specimen preparation, polishing abrasives and cloths, specimen mounting, electrolytic polishing, etching procedure and reagents, electrolytic etching, optical metallurgical microscope, macroscopy, sulphur printing, flow line observations, examination of fractures, spark test, electron microscope.

Unit 5: Strengthening Mechanisms and Non-destructive Testing [08 Hours]
Refinement of grain size, cold working/strain hardening, solid solution strengthening, dispersion strengthening, Precipitation hardening. Magnetic particle inspection, dye Penetrant inspection, ultrasonic inspection, radiography, eddy current testing, acoustic emission inspection.

Texts:

1. V. D.Kodgire, S.V.Kodgire, "Material Science and Metallurgy for Engineers", Everest Publishing House, Pune, 24th edition, 2008.
2. W. D.Callister, "Materials Science and Engineering: An Introduction", John Wiley and Sons, 5th edition,2001.
3. V.Raghvan, "Material Science Engineering", Prentice Hall of India Ltd., 1992.

References:

1. V. B.John, "Introduction to Engineering Materials", ELBS, 6thedition, 2001.
2. G. F.Carter, D. E.Paul, "Materials Science and Engineering", ASM International, 3rd edition, 2000.
3. T. E.Reed-Hill, R.Abbaschian, "Physical Metallurgy Principles", Thomson, 3rdedition

Machine Drawing and Computer Aided Drafting Lab

BTMCL305	PCC3	Machine Drawing and Computer-aided Drafting Lab	0-0-4	2 Credits

Practical Scheme:	**Examination Scheme:**
Practical: 4 hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Draw Conventional representation of standard machine components, welds, materials etc.
CO2	Draw sectional view of a given machine component.
CO3	Develop Assemble view from details of given component i.e. valve, pump, machine tool part, etc.
CO4	Combine details of given machine component and draw assembled view.
CO5	Use various Auto-Cad commands to draw orthographic projection
CO6	Draw sectional view from pictorial view of given machine component using Auto-Cad

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1		1				1			
CO2	2	1	1		1				1			1
CO3	3	1	1		1				2	1		2
CO4	3	1	1		1				2	1		1
CO5	2	1	1		2				2	2		1
CO6	1	1	1		1				1	1		1

Course Contents:

Unit 1: Sectional Views [04 Hours]
Full section, half section, partial section, off-set section, revolved sections, removed sections, auxiliary section, guidelines for hatching, examples on all above types of sections of machine elements.

Unit 2: Study of Machine Elements [04 Hours]
Study of simple machine elements and components such as screwed fasteners, shaft couplings, pipe joints, riveted and welded joints, bearings, gears, etc.

Unit 3: Interpenetration of Surfaces (Emphasis on Applied Cases)[04 Hours]

Line or curve of intersection of two penetrating cylinders, Cone and cylinder, prism and a cylinder, cone and prism, Forged ends, etc.

Unit 4: Drawing of Assembly and Details [04 Hours]
Part drawing of standard machine components such as valves, components of various machine tools, pumps, shaft couplings, joints, pipe fittings, engine parts, etc.

Production Drawing and Reading Blue Prints [04 Hours]
Types of production drawings, size, shape and description; limits, fits and tolerances, surface roughness and surface roughness symbols, reading the blue prints.

Unit 5: Computer Aided Drafting [04 Hours]
Introduction to Computer Aided Design and Drafting, Advantages of CADD, study of preliminary AutoCAD commands like drawing, dimensioning, viewing commands. Drawing 3D views in AutoCAD, Introduction to AutoLISP programming.

List of Practical's/ Experiments/ Assignments (minimum six assignments should be completed)

1. One full imperial drawing sheet consisting the drawing/sketches of representation of standard components, symbols of pipe joints, weld joints, rivet joint etc., surface finish symbols and grades, limit, fit and tolerance sketches.
2. Two full imperial drawing sheets, one consisting of assembly and the other consisting of details of any one standard component such as valves, components of various machine tools, pumps, joints, engine parts, etc.
3. Two assignment of AutoCAD: Orthographic Projections of any one simple machine component such as bracket, Bearing Housing or Cast component for Engineers such as connecting rod, Piston, etc.; with dimensioning and detailing of three views of components.
4. 3-D model at least one simple machine component.

Texts:
1. N. D. Bhatt,"Engineering Drawing", Charotar Publishing House, Anand, India.
2. N. D. Bhatt, "Machine Drawing", Charotar Publishing House, Anand, India.
3. Ajeet Sing, "Working with AutoCAD 2000", Tata McGraw Hill, New Delhi.
4. George Omura, "ABC of AutoLISP", BPB Publications, New Delhi.

References:
1. Narayana, Kannaiah, Reddy, "Machine Drawing", New Age International Publishers.
2. AutoCAD and AutoLISPmanuals from Autodesk Corp. U.S.A.
3. ISCode: SP46-1988, Standard Drawing Practices for Engineering Institutes.

Production Engineering Lab I

BTPCL306	PCC4	**Production Engineering Lab I**	0-0-6	3Credit

Practical Scheme:	**Examination Scheme:**
Practical: 6hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

List of Practical's/ Experiments/ Assignments (Any 4 from Group-A, Any 3 from Group-B and Any 3from Group-C)

Group-A (Fluid Mechanics)

1. Flow visualization technique: characteristics of laminar and turbulent flow patterns using Helleshaw Apparatus.
2. Verification of Bernoulli's theorem
3. Determination of Critical Reynolds number using Reynolds Apparatus
4. Determination of pressure drop in pipes of various cross-sections
5. Determination of pressure drops in pipes of various pipe fittings etc.
6. Viscosity measurement using viscometer(at least one type)
7. Verification of momentum equation using impact of jet apparatus
8. Determination of metacentric height of a floating body
9. Calibration of a selected flow measuring device and Bourdon pressure gauge
10. Gauge and differential pressure measurements using various types of manometers, Bourdon type pressure gauge.
11. Demonstration of measurement using these instruments Lab.
12. Experiment to study hydraulic jump.

Group-B (Material Science and Metallurgy Lab)

1. Brinell Hardness Test
2. Rockwell Hardness test
3. Erichson Cupping Test
4. Magnaflux Test
5. Dye Penetrant Test
6. Specimen Preparation for Microscopy
7. Sulphur Print Test

8. Spark Test
9. Study and drawing of microstructures of plain carbon steels of varying carbon percentage
10. Study and drawing of microstructures of heat treated steels
11. Jominy End Quench Test
12. Study and drawing of microstructures of cast irons
13. Study and drawing of microstructures of non-ferrous alloys
14. Hardening of steels of varying carbon percentage

Group-C (Thermal EngineeringLab)

1. Determination of dryness fraction of steam.
2. Trial on bomb calorimeter.
3. Study of MPFI and Bosh fuel injection pump
4. Study of High Pressure Boilers.
5. Test on Diesel/Petrol engine to determine BP, bsfc, Brake thermal efficiency.
6. Trial on reciprocating air compressor.
7. Determination of thermal conductivity of insulating material.
8. Test on parallel & counter flow heat exchanger.
9. Determination of Emissivity of a Test Plate.

IT – 1 Evaluation

BTES209P (IT – 1)	Internship – 1 Evaluation	PROJ-1	0L-0T-0P	1 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: --	Continuous Assessment: -- Mid Semester Exam: -- End Semester Exam: 100 Marks

Semester-IV

Casting and Moulding Technology

BTPC401	PCC 5	Casting and Moulding Technology	3-1-0	4Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks

	End Semester Exam: 60 Marks(Duration 03 hrs)

Objectives: To make students aware of different casting and moulding processes, foundry practices to design casting for different components.

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Classify different casting processes, advantages and limitations.
CO2	Identify various patterns and sand moulding processes.
CO3	Outline special casting processes, their advantages and limitations.
CO4	Select pouring and feeding methods of casting.
CO5	Design gating and risering system of casting.
CO6	Identify casting defects and various casting inspection and testing methods.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1				1							
CO2	1				1							
CO3	1				1							
CO4	1		1		1							
CO5	1		1		1							
CO6	1				1					1		1

Course Contents:

Unit 1: Introduction to casting processes [06 Hours]

Classification, advantages, limitations, applications of casting, casting terms, sand mold making procedure

Unit 2: Technology of patternmaking, moulding and core making [06 Hours]

Pattern materials, pattern making tools, types of patterns, pattern allowances, methods of Constructing patterns, color coding, tools and equipment's, types of modeling sands, sand Additives, properties of molding sand and testing, molding processes: green sand, dry sand Molding: advantages, limitations and applications core materials, core prints, core boxes, core making, and chaplets.

Unit 3: Special casting processes [06 Hours]

Shell molding, investment molding, full molding process, CO_2 molding, permanent mold Casting, die casting, centrifugal casting and continuous casting, advantages, limitations and applications

Unit 4: Melting, pouring and feeding [06 Hours]

Introduction of furnaces for ferrous and non-ferrous casting, use, construction, charging and other furnaces

Unit 5: Gating and risering of castings [06 Hours]

Gating system, gates, gating ratio, casting yield and gating system design

Risering of casting: Function, shape, types, location, feeding distance, and its design parameters.

Design considerations and inspection of casting [06 Hours]

Designing for economical molding and eliminating defects, defects in casting, inspection Methods: visual, dimensional, mechanical, metallurgical and NDT

Texts/References:

1. Heine R.W, Loper C.R and Rosenthal P.C , "Principles of metal casting", Tata McGraw Hill Publication Co.1998
2. P. L. Jain , "Principles of foundry technology", Tata McGraw Hill Education , New Delhi, 2003.
3. PN Rao, "Manufacturing Technology - Foundry, Forming and welding", Tata McGraw Hill, New Delhi, 2006.

Theory of Machines

BTPC402	Theory of Machines	PCC 6	3L-1T-0P	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/week Tutorial: 1hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: Applied Mechanics and Engineering Graphics

Course Outcomes: At the end of the course, students will be able to

CO1	Select appropriate mechanism to design and develop a machine for an application
CO2	Analyze the mechanisms to determine velocity and acceleration of various links of the mechanism
CO3	Design and draw profile of the cam to obtain specified follower motion for an application
CO4	Analyze the governor to determine its height for the corresponding change in speed and sleeve displacement
CO5	Explain lower pair mechanisms and select them to meet the need where they are suitable
CO6	Explain and apply friction concepts in automotive and mechanical applications.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		2	1								
CO2	1	2			1	1						
CO3	1		1	1								
CO4	1	2	1		1	1						
CO5	2											
CO6	2		2		2			1				

Course Contents:

Unit 1 [06 Hours]

Definition of link, pair, kinematics chain, inversions, inversions of single and double slider crank chain, kinematic diagrams of mechanisms, equivalent linkage of mechanism, degree of freedom, Study of various mechanisms, Steering system & mechanism, suspension.

Unit 2[06 Hours]

Velocity and acceleration analysis and its purpose, velocity and acceleration diagrams using relative velocity method, Corioli's component of acceleration, Velocity and acceleration analysis by vector methods, coordinate system, Loop closure equation, Chase solutions, velocity and acceleration by vector and complex algebra.

Velocity and acceleration of slider crank mechanism by analytical method and Klein's construction.

Unit 3[06 Hours]

Classification of gears, Terminology of spur gears, Conjugate action, Involute and cycloidal profile. Path of contact, contact ratio, Interference, Undercutting, Internal gears. Helical gear

terminology, Normal and transverse module, Torque transmitted by helical gears, Spiral gears, Efficiency of spiral gears, Worm and Bevel gear terminology.

Gear Trains: Velocity ratios, Types of gear trains, Tooth load, Torque transmitted and holding torque.

Unit 4[06 Hours]
Cams and Followers: Types of cams and followers, Analysis of motion, Jump and ramp of cam, Determination of cam profiles for a given follower motion.

Flywheel: Turning moment diagram, Fluctuation of energy and speed, Determination of flywheel size for different types of prime movers and machines.

Governors: Function of governor, Inertia and centrifugal type of governors, Controlling force analysis, Governor Effort and governor power, Sensitivity, stability, Isochronisms and Hunting, Friction insensitiveness.

Gyroscope: Principles of gyroscopic action, Precession and gyroscopic acceleration, gyroscopic couple, Effect of the gyroscopic couple on ships, aeroplanes and vehicles, inclined rotating discs, gyroscopic stabilization.

Unit 5 [10 Hours]
Friction Clutches: Principle, Functions, General requirements, Torque capacity, Types of clutches, Cone clutch, Single-plate clutch, Diaphragm spring clutch, Multi-plate clutch, Centrifugal clutch, Electromagnetic clutch, Lining materials, Over-running clutch, Clutch control systems.
Brakes & Braking System : Function and requirements of braking system, Types of brakes, Elementary theory of shoe brake, drum brake arrangement, disc brake arrangement, self-energizing, brake friction material. brake linkages, hydraulic brake system and components, hydraulic brake fluids, air brakes, vacuum servo assisted brake, engine exhaust brake, parking brakes, dual power brake system, regenerative brake system, fail-safe brake, anti – lock brakes, anti-skid brakes, brake efficiency and testing, weight transfer, braking ratio, ABS System.

Belt and Rope Drives: Flat belts, Effect of slip, Centrifugal tension, crowing of pulley, Initial tension in belts. V-BeltsGeometricrelationship,analysisofbelttensions,conditionformaximumpower,Selectionofflatandv-beltsfrommanufacturer'scatalogue, Adjustment of belt tensions.

Text Books:
1. A.Ghosh and, A.K.Malik, "Theory of Mechanisms and Machines", Affiliated East-WestPress Pvt. Ltd., NewDelhi.
2. S. S. Rattan, "Theory of Machines", Tata-McGraw Hill, NewDelhi.

Reference Books:
1. Thomas Beven, "Theory of Machines", CBS Publishers and Distributors", Delhi.
2. J.E.Shigely and J.J. Uicker, "Theory of Machines and Mechanisms", McGraw Hill, NewYork, International Student Edition,1995

Basic Human Rights

BTHM403	HSSMC3	Basic Human Rights	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Audit Course

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Understand the history of human rights.
CO2	Learn to respect others caste, religion, region and culture.
CO3	Be aware of their rights as Indian citizen.
CO4	Understand the importance of groups and communities in the society.
CO5	Realize the philosophical and cultural basis and historical perspectives of human rights.
CO6	Make them aware of their responsibilities towards the nation.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						2						
CO2												
CO3												
CO4									3			
CO5								2		2		
CO6												1

Course Contents:

Unit 1: The Basic Concepts, Fundamental Rights and Economic Program [08 Hours]
Individual, group, civil society, state, equality, justice. Human Values, Human rights and Human Duties: Origin, Contribution of American bill of rights, French revolution. Declaration of independence, Rights of citizen, Rights of working and exploited people

Society, religion, culture, and their inter-relationship. Impact of social structure on human behavior, Social Structure and Social Problems: Social and communal conflicts and social harmony, rural poverty, unemployment, bonded labour.

Unit 2: Workers and Human Rights [04 Hours]
Migrant workers and human rights violations, human rights of mentally and physically challenged. State, Individual liberty, Freedom and democracy.

Unit 3: NGOs and Human Rights in India [04 Hours]
Land, Water, Forest issues.
Unit 4: Human Rights in Indian Constitution and Law [04 Hours]
i) The constitution of India: Preamble
ii) Fundamental rights.
iii) Directive principles of state policy.

iv) Fundamental duties.
v) Some other provisions.

Unit 5: UDHR and Indian Constitution [04 Hours]
Universal declaration of human rights and provisions of India; Constitution and law; National human rights commission and state human rights commission.

References:
1. Shastry, T. S. N., "India and Human Rights: Reflections", Concept Publishing Company India (P Ltd.), 2005.
2. C. J. Nirmal, "Human Rights in India: Historical, Social and Political Perspectives (Law in India)", Oxford India.

Strength of Materials

BTMES404	ESC11	Strength of Materials	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks

	End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: Engineering Mechanics

Course Outcomes: At the end of the course, students will be able to:

CO1	State the basic definitions of fundamental terms such as axial load, eccentric load, stress, strain, E, μ, etc.
CO2	Recognize the stress state (tension, compression, bending, shear, etc.) and calculate the value of stress developed in the component in axial/eccentric static and impact load cases.
CO3	Distinguish between uniaxial and multiaxial stress situation and calculate principal stresses, max. Shear stress, their planes and max. Normal and shear stresses on a given plane.
CO4	Analyze given beam for calculations of SF and BM
CO5	Calculate slope and deflection at a point on cantilever /simply supported beam using double integration, Macaulay's , Area-moment and superposition methods
CO6	Differentiate between beam and column and calculate critical load for a column using Euler's and Rankine's formulae

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents:

Unit 1: Simple Stresses and Strains [12 Hours]

Mechanical properties of materials, analysis of internal forces, simple stresses and strains, stress-strain curve, Hooke's law, modulus of elasticity, shearing, thermal stress, Hoop stress, Poisson's ratio, volumetric stress, bulk modulus, shear modulus, relationship between elastic constants.

Principal Stresses and Strains

Uni-axial stress, simple shear, general state of stress for 2-D element, ellipse of stress, principal stresses and principal planes, principal strains, shear strains, strain rosettes, Mohr's circle for stresses and strains

Unit 2: Strain energy, resilience and Combined Stresses [10 Hours]

Strain energy, resilience: Combined axial and flexural loads, middle third rule, kernel of a section, load applied off the axes of symmetry.

Shear and Moment in Beams: Shear and moment, interpretation of vertical shear and bending

moment, relations among load, shear and moment.

Unit 3: Stresses in Beams [08 Hours]
Moment of inertia of different sections, bending and shearing stresses in a beam, theory of simple bending, derivation of flexural formula, economic sections, horizontal and vertical shear stress, distribution shear stress for different geometrical sections-rectangular, solid circular, I-section, other sections design for flexure and shear.

Unit 4: Torsion [08 Hours]
Introduction and assumptions, derivation of torsion formula, torsion of circular shafts, stresses and deformation indeterminate solid/homogeneous/composite shafts, torsional strain energy.
Columns and Struts: Concept of short and long Columns, Euler and Rankine's formulae, limitation of Euler's formula, equivalent length, eccentrically loaded short compression members.

Unit 5: Beam Deflections [08 Hours]
Differential equation of deflected beam, slope and deflection at a point, calculations of deflection for determinate beams by double integration, Macaulay's method, theorem of area-moment method (Mohr's theorems), moment diagram by parts, deflection of cantilever beams, deflection in simple supported beams, mid-span deflection, conjugate beam method, deflection by method of superstition.

Texts:
1. S. Ramamrutham, "Strength of Materials", DhanpatRai and Sons, New Delhi.
2. F. L. Singer, Pytle, "Strength of Materials", Harper Collins Publishers, 2002.
3. S. Timoshenko, "Strength of Materials: Part-I (Elementary Theory and Problems)", CBS Publishers, New Delhi.

References:
1. E. P.Popov, "Introduction to Mechanics of Solid", Prentice Hall, 2nd edition, 2005.
2. S. H. Crandall, N. C. Dahl, T. J. Lardner, "An introduction to the Mechanics of Solids", Tata McGraw Hill Publications, 1978.
3. S. B. Punmia, "Mechanics of Structure", Charotar Publishers, Anand.

Numerical Methods in Mechanical Engineering

BTMPE405A	PEC 1	Numerical Methods in Engineering	3-1-0	4 Credits

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Course Outcomes: At the end of the course, students will be able to:

CO1	Describe the concept of error
CO2	Illustrate the concept of various Numerical Techniques
CO3	Evaluate the given Engineering problem using the suitable Numerical Technique
CO4	Develop the computer programming based on the Numerical Techniques

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		1	3							
CO2	3	3		1	3							
CO3	3	3		1	3							
CO4	3	3		1	3							

Course Contents:

Unit1: Error Analysis [06 Hours]
Significant figures, round-off, precision and accuracy, approximate and true error, truncationerrorand Taylor series, machine epsilon, data uncertainties, error propagation, importance of errors in computer programming.

Unit2: Roots of Equations [06 Hours]
Motivation, Bracketing methods: Bisection methods, Open methods: Newton Raphson method, Engineering applications.

Unit3: Numerical Solution of Algebraic Equations [06 Hours]
Motivation, Cramer'srule, Gauss- Elimination Method, pivoting, scaling, engineering applications.

Unit4: Numerical Integration and Differentiation [06 Hours]
Motivation, Newton's Cotes Integration Formulas: Trapezoidal Rule, Simpson's rule, engineering applications Numerical differentiation using Finite divide Difference method

Unit5: Curve, Fitting and Interpolation and Computer Programming [12 Hours]
Motivation, Least Square Regression: Linear Regression, Polynomial regression.
Interpolation: Newton's Divide Difference interpolation, engineering applications.
Solution to Ordinary Differentiation Equations: Motivation**,** Euler's and Modified Euler's Method, Heun'smethod, Runge–KuttaMethod, engineering applications.

Computer Programming

Overview of programming language, Development of at least one computer program based on each unit.

Texts:

1. Steven C Chapra, ReymondP.Canale, "Numerical Methods for Engineers",TataMcGraw Hill Publications,2010.
2. E. Balagurusamy, "Numerical Methods", Tata McGraw Hill Publications, 1999.

References:

1. V. Rajaraman, "Fundamental of Computers", Prentice Hall of India, New Delhi,2003.
2. S. S. Sastri,"IntroductoryMethodsofNumericalMethods",PrenticeHallofIndia,NewDelhi, 3rd edition,2003.
3. K. E. Atkinson, "An Introduction to Numerical Analysis", Wiley, 1978.
4. M.J. Maron, "Numerical Analysis: A Practical Approach", Macmillan, New York, 1982

Sheet Metal Engineering

BTMPE405B	PEC 1	Sheet Metal Engineering	3-1-0	4 Credits

Teaching Scheme:	Examination Scheme:
Lecture: 3hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Recognize common manufacturing processes of Sheet Metal Fabrication
CO2	Understand the principles of design and fabricate of sheet metal products and recognize common material used in the industry
CO3	Distinguish Shearing, Drawing and Pressing etc. processes.
CO4	Know types of dies and formability.
CO5	Select mechanical or hydraulic presses for the given process

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	3	2				2	1		1
CO2	3			1	3	2	3					2
CO3	1	1		3	3	2	1		3		1	3
CO4	3	3	1	1	3		1	1	1			
CO5	3	2			3	3	2				1	3

Course Contents:

Unit1: Introduction
Importanceofsheetmetalengineering,materialsused,desirableproperties ofmaterialsin sheetmetalproducts

Unit2: BasicApplications
Shearingprocesseslikeblanking,piercing,andpunching.

Unit3: DrawingProcesses
Shallowanddeepdrawingofcylindricalandrectangularbodies, formingandbendingincludingspring-back.

Unit4: TypesofDies and Mechanical Presses
Dies:Compounddies,progressivedies,andcombinationdies
Mechanical Presses
Mechanicalandhydraulicpresses,moderndevelopmentsinpresstools, formability.

Unit 5: Case Studies

Casestudiesformanufacturingofsheetmetalproductsinvariousengineeringapplications

Texts:

1. Donaldsonet al., "ToolDesign",TataMcGraw-Hill Publications,NewDelhi, 1998.

References:

1. P.N.Rao,"ManufacturingTechnology,Foundry,FormingandWelding",Vol.I,TataMcGrawHill PublishingCo.Ltd,NewDelhi,3rdedition, 2004.
2. ASMHandbook, "MetalForming",Vol.XV,ASMPublication,Metals Park, Ohio,10thedition,1989.
3. A. S.Deshpande, "DieDesignHandbook",ASTME.
4. SheetMetalEngineeringNotes,IITBombay,1999.

Fluid Machinery

BTMPE405C	PEC 1	Fluid Machinery	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Understand and apply momentum equation
CO2	Understand and explain Hydrodynamic Machines
CO3	Explain difference between impulse and reaction turbines
CO4	Find efficiencies, draw velocity triangles
CO5	Explain governing mechanisms for hydraulic turbines
CO6	Explain working of various types of pumps, draw velocity diagrams, do simple calculations
CO7	Design simple pumping systems

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									1
CO2	3		3				2					1
CO3	3	2										1
CO4	3	3	2									1
CO5			3									1
CO6	3	3	3	1	1							1
CO7	3	3		3								1

Course Contents:

Unit 1: Momentum Equation and its Applications

Impulse momentum, Principle, Fixed and moving flat inclined plates, Curved vanes, Series of plates and vanes, Velocity triangle and their analysis, Water wheels. Hydrodynamic Machines: Classification, General theory, Centrifugal head, Fundamental equations, and Euler's equation, Degree of reaction, Head on machine, various efficiencies, Condition for maximum hydraulic efficiency.

Unit 2: Impulse and Reaction Turbines

Impulse principle, Construction of Pelton wheel, Velocity diagrams and its analysis, Number of buckets, Jets, Speed ratio, Jet ratio.

Reaction Turbines: Constructional details of Francis, Kaplan and Propeller turbine, Deciaz turbine, and Draft tube types, Efficiencies, Cavitation.

Unit 3: Governing of Turbines

Methods of governing, Performance characteristics, Safety devices, Selection of turbines, Unit quantities, Specific speed, Principles of similarity and model testing.

Unit 4: Centrifugal Pump

Construction, Classification, Terminology related to pumps, Velocity triangle and their analysis, Cavitation, NPSH, Thoma's cavitation factor, Priming, Methods of priming, Specific speed, Performance characteristics, Actual thrust and its compensation, Troubleshooting.

Multistage Pumps: Pump H-Q characteristics and system H-Q Characteristics, Series and parallel operation of pumps, Systems in series and parallel, Principle of model testing and similarity.

Unit 5: Special Purpose Pumps

Chemical pumps, nuclear pumps, Sewage pumps, Submersible deep well pumps, Pump installation, Energy efficient pumps.

Failure of Pumping System: Pump failures, Remedies, Source failure, Causes and remedies, Trouble shooting.

Miscellaneous Pumps: Reciprocating pump, Gear pump, Vane pump, Lobe pump, etc., Application field (no mathematical treatment).

Texts:

1. P. N. Modi, S. M. Seth, "Hydraulics and Fluid Mechanics including Hydraulic Machines", Standard Book House, Rajsons Publications Pvt. Ltd., 20th edition.
2. R. K. Bansal, "A Text Book of Fluid Mechanics and Hydraulic Machines", Lakshmi Publications Pvt. Ltd., 9th edition.

References:

1. Yunus A. Çengel, John M. Cimbala, Fluid Mechanics: Fundamentals and Applications", McGraw Hill, 3rd edition, 2014.

Production Engineering Lab-II

BTPCL406	PCC7	**Production Engineering Lab II**	0-0-4	2Credit

Practical Scheme:	**Examination Scheme:**
Practical: 4hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

List of Practical's/Experiments/Assignments (Any 5 from Group-A and Any 5 from Group-B)

Group-A (Theory of Machines):

1. Determination of Moment of Inertia of rigid bodies by bifilar or trifilar suspension method.
2. Compound Pendulum.
3. Experimental Verification of displacement relation for different shaft angles for single Hook's Joint.
4. Developing a computer program for velocity and acceleration of slider crank mechanism.
5. Graphical solution of problems on velocity & acceleration in mechanisms by Relative velocity & relative acceleration method including problem with Corioli's component of acceleration.
6. Graphical solution of problems on velocity in mechanisms by ICR method.
7. Klein's constructions for slider crank mechanism.
8. Inertia force analysis with graphical methods.
9. Straight line motion mechanisms.

Group-B (Strength of Material):

1. Tension test on ferrous and non-ferrous alloys (mid steel/cast iron/aluminum, etc.
2. Compression test on mild steel, aluminum, concrete, and wood
3. Shear test on mild steel and aluminum (single and double shear tests)
4. Torsion test on mild steel and cast iron solid bars and pipes
5. Flexure test on timber and cast iron beams
6. Deflection test on mild steel and wooden beam specimens
7. Graphical solution method for principal stress problems
8. Impact test on mild steel, brass, aluminum, and cast iron specimens

9. Experiments on thermal stresses
10. Strain measurement in stress analysis by photo-elasticity
11. Strain measurement involving strain gauges/ rosettes
12. Assignment involving computer programming for simple problems of stress, strain computations

Semester V

Design of Machine Elements

BTPC501	Design of Machine Elements	PCC 8	3L-1T-0P	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Objectives: To understand material properties, design process and various theories of failures in order to design various basic machine components and new components based on design

principles.

Pre-Requisites: Strength of Materials

Course Outcomes: At the end of the course, students will be able to:

CO1	Formulate the problem by identifying customer need and convert into design specification
CO2	Understand component behavior subjected to loads and identify failure criteria
CO3	Analyze the stresses and strain induced in the component
CO4	Design of machine component using theories of failures
CO5	Design of component for finite life and infinite life when subjected to fluctuating load
CO6	Design of components like shaft, key, coupling, screw and spring

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1						1				1
CO2	3	2		1		1		1		1		1
CO3	1	1				1		1		1		1
CO4	3	3	2	1		2		1		1		1
CO5	1	1				1		1		1		1
CO6	2	2	2	1		1		1		1		1

Course Contents:

Unit1:

MechanicalEngineeringDesignProcess

Traditionaldesignmethods, generalindustrialdesignprocedure,designconsiderations, phasesindesign, creativity indesign,useofstandardization, preferredseries,introduction toISO9000,useofdesigndatabook,aestheticandergonomic considerationsindesign.

Theories of Failure: Maximumnormalstresstheory,Maximumshearstresstheory,Maximumdistortionenergytheory,comparisonofvarioustheoriesoffailure,

Unit2:DesignofMachineElements

I. Against StaticLoading

Directloadingandcombinedloading,Jointssubjectedtostaticloadinge.g. cotterandknucklejoint,turnbuckle,etc.introduction to fluctuatingloads.

II: Against Fluctuating Loads

Stress concentration, stress concentration factors, fluctuating stresses, fatigue failure, endurance limit, notch sensitivity, approximate estimation of endurance limit, design for finite life and finite life under reversed stresses, cumulative damage in fatigue, Soderberg and Goodman diagrams, fatigue design under combined stresses.

Unit 3: DesignofShafts, Keys, Couplings and Bearings

Variousdesignconsiderationsintransmissionshafts, splined shafts, spindle and axlesstrength, lateral and torsional rigidity, ASME code for designingtransmissionshaft.

TypesofKeys: Classificationandfitmentinkeyways,Designofvarioustypesofkeys.
Couplings: Designconsideration,designofrigid,muffandflangetypecouplings, designofflexiblecouplings.
Bearings: Types, Constructional details of roller contact and sliding contact bearings, Static and dynamic load carrying capacities, Stribeck'sEquation, Equivalent load, loadandliferelationship, selection ofbearinglife, Load factor,selection of bearing from manufacturer's catalogue, Lubrication and bearing materials.

Unit 4:DesignofThreaded Joints
Stressesinscrewfasteners,boltedjointsundertension,torque requirementforbolttightening,preloadingofboltunderstaticloading,eccentricallyloaded boltedjoints.
PowerScrews: Formsofthreadsusedforpowerscrewandtheirapplications,torqueanalysisfor squareandtrapezoidalthreads,efficiencyofscrew,collarfriction,overallefficiency,self-lockinginpowerscrews,stressesinthepowerscrew,designofscrewandnut,differentialandcompound screw,re-circulatingballscrew.
Welded Joints:
Typeofweldedjoints,stressesinbuttandfilletwelds,strengthofweldedjointssubjectedtobendingmoments.

Mechanical Springs
Stressdeflectionequationforhelicalspring,Wahl'sfactor,styleofends, designofhelicalcompression, tensionandtorsionalspringunderstaticloads,constructionanddesignconsiderationinleafsprings,nipping

Unit 5: Design of Gears and Drives
Geardrives, Classification ofgears, Lawofgearing,Terminologyofspurgear, Standard system of geartoothforceanalysis,geartoothfailures,material selection,Numberofteeth,Facewidth,Beamstrengthequation,Effectiveloadongeartooth,Estimationofmodulebasedonbeamstrength.
Design formaximumpowercapacity, Lubricationofgears.
HelicalGears:
Terminology,Virtualnumberofteeth,Toothproportions,Forceanalysis,Beamstrengthequation,Effectiveloadongeartooth,Wearstrengthequation.
BevelGears: Typesofbevelgears,Terminologyofstraightbevel,forceanalysis,BeamandWearstrength,Effectiveloadongeartooth.
WormGears: Terminology,Proportions,Forceanalysis,Frictioninwormgears,Vectormethod, Selectionofmaterials,Strengthandwearrating,Thermalconsiderations

Texts:
1. V. B.Bhandari, "DesignofMachineElements",TataMcGrawHill Publications,NewDelhi,2008.
2. R. L.Nortan, "MachineDesign:AnIntegratedApproach",PearsonEducationSingapore, 2001.

References:

1. R. C.Juvinall, K. M.Marshek, "Fundamentalofmachinecomponentdesign",John Wiley&SonsInc.,NewYork,3rdedition,2002.
2. B. J. Hamrock,B. JacobsonandSchmidSr., "FundamentalsofMachineElements", InternationalEdition,NewYork,2ndedition,1999.
3. A. S.Hall,A. R.Holowenko, H. G.Langhlin,"TheoryandProblemsofMachineDesign",Schaum'sOutlineSeries, Tata McGrawHillbookCompany,NewYork,1982.
4. J. E.ShigleyandC.Mischke, "MechanicalEngineeringDesign", Tata McGrawHill Publications,7thedition, 2004.
5. M. F.Spotts, "DesignofMachineElements",PrenticeHallofIndia,NewDelhi.

Metal Forming Processes

BTPC502	PCC 9	Metal Forming Processes	3-1-0	4Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Objectives: To apply basic of metal forming processes to shape products to their desired forms without any defects.

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Define basic stress strain relationship and failure criteria.
CO2	Identify effect of temperature, strain rate and microstructure on formability.
CO3	Calculate the roll separating force, pressure and power required for rolling.
CO4	Determine forces and power required in forging and extrusion.
CO5	Estimate bending force, spring back, effect in bending and forces in wire drawing.
CO6	Classify various advanced forming processes.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1				1							
CO2	1				1							
CO3	1		1	1	1							
CO4	1		1	1	1							
CO5	1		1	1	1							
CO6	1				1							

Course Contents:

Unit 1: Stress and Strain

Review of the theory of stress and Strain – transformation laws –principal stress and strain – Mohr's circle, Stress strain relations, Material properties, Theory of plasticity, Behaviour of metals under uni-axial tension and compression — true stress-true strain relations — effect of work hardening, Empirical stress-strain relations for work hardening materials. Representation of Tresca and von-Mises criterion –yield surface for work hardening materials, Stress strain relations in the plastic range

Unit 2: Metal Forming Processes

Effect of temperature, strain rate, metallurgical microstructure, chemical composition and mechanical properties, Classification of material forming process, Hot forming/ Cold forming, Concept of Formability, formability limits and formability diagram.

Unit 3: Mechanics of Rolling Process

Rolling, process parameters, pressure distribution and roll separating force, rolling pressure, driving torque and power requirements. Defects in rolling. Automatic gauge control- Roll pass classification & design.

Unit 4: Forging and Extrusion

Forging: Determination of forces in strip forging and disc forging, defects in forged components.

Extrusion: Process, parameters, determination of work load from stress analysis and energy

considerations, power loss, hydrostatic extrusion, pressure required to extrude, variables affecting the process.

Unit 5: Bending, Punching and Blanking

Bending: Bendability, determination of work load and spring back.

Punching & Blanking: Two-dimensional deformation model and fracture analysis, determination of working force.

Introduction rod and wire drawing machines - construction and working. Preparation of stock for wire drawing. Wire drawing dies, material and design. Patenting heat treatment. Variables in wire drawing, Maximum reduction in wire in one pass, forces required in drawing.

Advanced metal forming processes

High velocity forming- principles, comparison of high velocity and conventional Forming processes. Explosive forming, Magnetic pulse forming, Electro hydraulic Forming, Microforming, Microcoining, microextrusion, Microbending, Stretch forming, coining embossing, curling spinning, flow forming advantages, limitations and application of the process.

Texts:

1. P.N.Rao, "ManufacturingTechnology, Foundry,FormingandWelding" Vol.1, 3rd edition, TataMcGrawHillPublishingCo.Ltd,NewDelhi,2004

References:

1. ASMHandbook,Vol.15MetalForming,ASM International,MetalsPark, Ohio,1989.
2. DieDesignHandbook,ASTME,1989.
3. A.S.Deshpande, "SheetMetalEngineeringNotes", IITBombay,1999.

Joining Technology

BTPC503	PCC 10	Joining Technology	3-1-0	Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Objectives: To apply the basics of metal joining processes to join different metals with appropriate technique for joining suitable materials.

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Classify various joining processes and identify welding symbols, joints and edge preparation.
CO2	Identify various arc welding methods, equipment's and electrodes.
CO3	Outline gas welding and their equipment's and classify resistance welding processes.
CO4	Define various solid state welding processes, thermal cutting and their working principles.
CO5	Outline welding defects and their causes, destructive and non-destructive testing of welds.
CO6	Choose suitable welding fixtures, estimate cost of welding.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1				1							
CO2	1				1							
CO3	1				1							
CO4	1				1							
CO5	1				1							1
CO6	1		1		1		1					

Course Contents:

Unit 1: Fundamentals and Classification of Welding Processes

Introduction, classification of Welding processes. Comparison with other joining processes, advantages, disadvantages, practical applications. Welding symbols, Basic & supplementary weld symbols, types of weld Joints, Selection of Weld Joint, and edge preparation.

Unit 2: Arc Welding Processes and Equipments

Definition, types of processes, Carbon Arc Welding, Flux Shielded Metal Arc Welding, Submerged Arc Welding, Tungsten Inert Gas Welding, Metal Inert Gas Welding, Electroslag Welding, Electro Gas Welding, Plasma Arc Welding , Arc Welding equipments, Electrodes Types, classification and coding of electrodes.

Unit 3: Welding, Soldering and Brazing

Principle of operation, types of flames, Gas welding Techniques, filler material and fluxes, Gas welding equipments, advantages and applications

Resistances welding: Definition, Fundamentals, variables advantages and application, Spot Welding, Heat Shrinkage, Heat Balance Methods, Equipment, Electrodes, Seam, Projection Butt

(up sets and flash), Percussion Welding – Definition, Principle of Operation, equipment, Metal Welded, advantages and application.

Soldering and Brazing: Definition, Comparison of Soldering, Brazing and Welding, principle, joint design, filler alloy, fluxes, processes and application.

Unit 4: Solid State Welding Processes

Cold Welding, Diffusion Welding, Ultrasonic Welding, Explosive Welding, Friction Welding, Inertia and Forge Welding – Definition, principle of operation advantages, limitation and application.

Thermal Cutting of Metal: Oxy-Fuel, Oxygen-Lance, Metal Powder, Chemicals Flux Cutting, Arc Cutting- Metallic, Air Carbon, Tungsten Arc, Plasma Arc Cutting

Unit 5: Weld Defects and Inspection

Weldability: Definition, effect of alloying elements, Purpose and types of tests, Hot Cracking, Root Cracking and Cold Cracking Tests. Common Weld defects, Causes and remedies. Concept of distortion, Types of distortion, Control of welding distortion

Destructive testing of weld – Tensile, Bend, Impact, Nick Break, Hardness, Etch Tests, Non Destructive Testing of Welds – Visual, Leak, X- ray and Gamma ray Radiography, Magnetic Particle Inspection, Dye, Fluorescent Penetrant Tests, Ultrasonic Inspection & Eddy Current Testing

Welding Automation and Robotics

Introduction, Automation options, Simple Mechanization, Dedicated and Special Purpose Automation, Robotic welding, Modular Automation, Programmable control, Remote Control Slave and Automated Systems

Welding Fixtures: Introduction, welding fixtures, their characteristics, classification and selection considerations, Principles governing design of good welding fixtures, various types of welding fixtures.

Estimation of Welding Cost: Introduction, main components costs of welding processes, factors involved in welding costs, basic costing procedure for arc welding, basic costing procedure for gas welding, factors affecting welding costs.

Texts:

1. O.P. Khanna, “Welding Technology” Khanna Publisher
2. Richard Little, “Welding & Welding Technology” TMH
3. N. K. Srinivasan, “Welding Technology” Khanna Publisher
4. Dr. R.S.Parmar, “Welding Processes and Technology” Khanna Publisher

References:

1. Md. Ibrahim Khan, “Welding Science & Technology” New Age International
2. V. M. Radhakrishnan, “Welding Technology & Design” New Age International Publisher
3. James E Brambaugh, “Welding Guide and Handbook” Taraporwala Mumbai
4. A.L. Davies, “Welding” Cambridge University Press
5. P. T. Houltcroft, “Welding Process Technology” Cambridge University Press
6. L.M.Gourd, “Principles of Welding Technology” ELBS

Refrigeration and Air Conditioning

BTMPE504A	PEC 2	Refrigeration and Air Conditioning	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Unit 1: Introduction
History, Fundamentals of refrigeration, Unit, Applications, Methods of producing cooling, Refrigeration systems, Thermodynamics of refrigeration, Primary and secondary refrigeration, Heat Pump

Unit 2: Vapour Compression System

Thermodynamics analysis, theoretical and actual cycle, Use of P-h and T-s diagram for problem solving, COP, Effect of evaporator and condenser temperature on cycle performance, Effects of suction superheating
Liquid sub-cooling, liquid-vapour heat exchanger, estimation of compressor displacement, COP and power requirement, waste heat recover opportunities

Unit 3:
Compound Vapour Compression System: Multi-evaporator, multi-compressor systems, cascade system (no mathematical treatment)
Vapour Absorption System: Aqua-ammonia system, lithium bromide-water system, Electrolux refrigerator, comparison with vapour compression cycle (descriptive treatment only), P-T-ξ

chart, thermodynamic analysis, and capacity control, solar refrigeration system

Unit 4:
Refrigerant for Vapour Compression System: Desirable Properties, Selection, Zeotrops and Azeotropes, Necessity for replacement of CFC refrigerants, natural refrigerants
Air Conditioning: Psychrometry, properties of moist air, psychrometric charts.
Thermal comfort: Heat transfer from human body by sensible and latent heat transfer, metabolic heat generation, steady state model for heat transfer, effect of clothing and definition of effective temperatures, comfort conditions, human comfort, comfort chart.

Unit 5: Air Conditioning Process Calculation
Sensible and latent heat loads, SHF, GSHF, RSHF, outside conditions, indoor conditions, estimation of coil capacity required, bypass factor, evaporative cooling
Principle of air distribution, duct design methods, friction chart, duct materials, methods of noise control
All air system, all water system, unitary systems; window air-conditioner, split air-conditioners, refrigeration and air-conditioning controls.

Texts:

1. Arora, C.P., Refrigeration and Air Conditioning, Tata McGraw Hills, New Delhi, Second Edition, 2000.

2. Stoeker, W.F. and Jones, J.P., Principles of Refrigeration and Air Conditioning, McGraw Hill, New York, Second Edition, 1982.

References:

1. ASHRAE Handbook – Fundamentals and Equipment, 1993.

2. ASHRAE Handbook – Applications, 1961.

3. ISHRAE Handbook

4. NPTEL Lectures by Prof. RamGopal, IIT Kharagpur

5. Carriern Handbook

6. Jord R.C., and Priester, G.B., Refrigeration and Air Conditioning, Prentice - Hall of India Ltd., New Delhi, 1969.

7. Threlkeld, J.L., Thermal Environmental Engineering, Prentice Hall, New York, 1970.

Engineering Tribology

BTMPE504C	PEC2	Engineering Tribology	3-0-0	Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Understand the basic concepts and importance of tribology.
CO2	Evaluatethenatureofengineeringsurfaces,theirtopographyandsurface characterization techniques
CO3	Analyze the basic theories of friction and frictional behavior of various materials
CO4	Select a suitable lubricant for a specific application
CO5	Compare different wear mechanisms
CO6	Suggest suitable material combination for tribological design.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2	2	1	2	2		1						

CO3	2	3	1	2	1	1	1					
CO4	2	2	2		1	1	2		1		1	
CO5	1	1	1	1	1							
CO6	2	2	2		2	2	2		1	1	1	

Course Contents:

Unit1: Introduction

Definition of tribology, friction, wear and lubrication; importance of the tri-biological studies.

Surface Topography**:** Methods of assessment, measurement of surface roughness-different statistical parameters (R_a,R_z,R_{max},etc.),contact between surfaces, deformation between single and multiple as peritycontact, contact theories involved

Unit2: Friction

Coulomb laws of friction, its applicability and limitations, comparison between static, rolling and kinetic friction, friction theories, mechanical inter locking, molecular attraction, electrostatic forces and welding, shearing and ploughing, models for asperity deformation.

Unit3: Lubrication

Types of lubrication, viscosity, characteristics of fluids as lubricant, hydrodynamic lubrication, Reynold's equation, elasto-hydrodynamic lubrication: partial and mixed, boundary lubrication, various additives, solid lubrication.

Unit4: Wear Sliding wear: Abrasion, adhesion and galling, testing method spin-on-disc, block-on-ring, etc., theory of sliding wear, un-lubricated wear of metals, lubricated wear of metals, fretting wear of metals, wear of ceramics and polymers.

Wearing by plastic deformation and brittle fracture. Wear by hard particles: Two-body abrasive wear, three-body abrasive wear, erosion, effects of hardness shape and size of particles.

Unit5: Wear and Design and Materials for Bearings

Introduction, estimation of wear rates, the systems approach, reducing wear by changing the operating variables, effect of lubrication on sliding wear, selection of materials and surface engineering. Principles and applications of tribo design

Materials for Bearings

Introduction, Rolling bearings, Fluid film lubricated bearings, marginally lubricated and dry bearings, gas bearings.

Texts:

1. I. M. Hutchings, "Tribology, Friction and Wear Engineering Materials", Edward Arnold, London.
2. R. C. Gunther, "Lubrication",BailyBrothersandSwinfenLimited.
3. F. T. Barwell, "BearingSystems,PrinciplesandPractice",OxfordUniversityPress.

References:

1. B. C. Majumdar, "IntroductiontoTribologyofBearings",A. H.Wheeler&Co.PrivateLimited,Allahabad.

2. D. F. Dudley, " TheoryandPracticeofLubricationforEngineers",JohnWilleyandSons.
3. J. Halling, "PrinciplesofTribology",McMillanPressLimited.
4. CameronAlasTair, "BasicLubricationTheory",WileyEasternLimited.
5. M. J. Neale, "TribologyHandbook",Butterworth's.
6. D. D. Fuller, "Lubrication".

Automobile Design (Product Design, PLM, CAE, Catia)

BTAPE504A	Automobile Design (Product Design, PLM, CAE, Catia)	PEC 2	3L-0T-0P	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Domain related training (Approx. 20 Hrs)

Unit 1:

Introduction to Styling, Basic of Design - Introduction to Design, Good Design & it's Examples of All Time, Industrial Design & its use. Design Process - Typical Product Life Cycle, Automotive Design Process (for production release), Design Studio (Automotive studio) Process or Product Conceptualization Process, Case Study. CAS Surfaces or Digital Clay Models, Class A Surfaces - Role of Class A surface Engineer, Requirements for a Surface to fulfill " Class A Surface" Standards, Case Studies for Class A Surfaces, Class A Surface Creation for Bonnet

Unit 2:

Introduction to Body In White: Introduction & familiarization to Body In White (BIW), various type of BIW, Types of BIW sub system, various aggregates of BIW. Bonnet Design Case Study:Function of Bonnet, Defined Input to Bonnet, Intended Input to Bonnet Design. Steps in Bonnet design, Study of Class A Surfaces, Hood Package Layout , Typical Sections, Block Surfaces in 3D, Dynamic Clearance Surfaces in 3D, Hood Structural Members, CAE 1(Durability, Crash), Panel Detail Design, Body Assembly Process, CAE 2(Durability, crash, individual panel level), Design Updating & Detailing Prototypes, Design Updating & Production Release

Unit 3:

Introduction to CAE & its importance in the PLM, Introduction to FEA & its applications (NVH, Durability & Vehicle Crashworthiness). Introduction of Pre-Processor, Post-Processor & Solvers. Importance of discretization & Stiffness Matrix (for automobile components). Importance of oil canning on an automobile hood with Case study related to Durability Domain. Modal analysis on the hood (Case Study related to NVH Domain). Introduction of vehicle crashworthiness & Bio-mechanics (Newtonian laws, energy management, emphasis of impulse in car crashes). Head impact analysis as a Case study on the hood of an automobile (EuroNCAP test regulation). Importance of Head performance criteria (HPC). Introduction to failure criteria (By explaining the analogy of using uni-axial test results for predicting tri-axial results in reality), Mohr's Circle, Von-Mises stress criteria, application of various failure criteria on brittle or ductile materials

Unit 4:

Introduction to CAD,CAM & CAE, FEA - Definition, Various Domains – NVH, Dura, Crash, Occupant Safety, CFD. Implicit vs. Explicit Solvers, Degree of Freedom, Stiffness Matrix, Pre-Post & Solver; Types of solvers, Animation. Durability -Oil Canning, Oil Canning on Hood, Scope of work, Loading, Boundary Conditions, Results & Conclusions. NVH – Constrained Modal Analysis, Constrained Modal Analysis on Hood, Scope of work, Loading, Boundary Conditions, Results & Conclusions. Crash – Vehicle Crashworthiness, Energy Management, Biomechanics, Head Impact Analysis on Hood, Importance of Failure Criteria, Von-Mises Stress

Unit 5:

Sheet metal design & Manufacturing Cycle, Simultaneous Engineering (SE) feasibility study, Auto Body & its parts, Important constituents of an automobile, sheet metal, sheet metal

processes. Type of draw dies, Draw Model development & its considerations. Forming Simulations, Material Properties, Forming Limit Curve (FLD), Pre Processing, Post-Processing, Sheet metal formability- Simulation

Die Design –Sheet metal parts, Sheet metal operations (Cutting, Non-Cutting etc.), Presses, Various elements used in die design, Function of each elements with pictures, Types of dies, Animation describing the working of dies, Real life examples of die design. **Fixture Design -** Welding (Spot/Arc Welding), Body Coordinates, 3-2-1 principle, Need for fixture, Design considerations, Use of product GD&T in the fixture design, fixture elements. Typical operations in Sheet metal Fixture (Manual/Pneumatic/Hydraulic fixture), Typical unit design for sheet metal parts (Rest/Clamp/Location/Slide/Dump units/Base), Types of fixture (Spot welding/ Arc welding/ Inspection fixture/Gauges)

Tools related training (Approx. 20 Hrs):

Depending on the tools available in the college, the relevant tool related training modules shall be enabled to the students.

AutoCAD, AutoCAD Electrical, AutoCAD Mechanical, AutoCAD P&ID, Autodesk 3ds Max, Autodesk Alias, Autodesk SketchBook, Automotive, CATIA V5, CATIA V6, FEA, Autodesk Fusion 360, Autodesk Inventor, Autodesk Navisworks, Autodesk Ravit, Autodesk Showcase, Autodesk Simulation, PTC Creo, PTC ProENGINEER, Solid Edge, SOLIDWORKS.

Texts:

1. Notes of TATA Technologies
2. Curt Larson, " Datum Principles: Flexible Parts: Applications for Automotive Body-in-White and Interior Trim (Dimensional Management Series Book 1)", Right Tech, Inc., Kindle Edition.
3. Curt Larson, " Datum Principles: Flexible Parts: Applications for Automotive Body-in-White and Interior Trim (Dimensional Management Series Book 2)", Right Tech, Inc., Kindle Edition.
4. VukatoBoljanovic, "Sheet Metal Forming Processes and Die Design", Industrial press Inc., Kindle Edition.

References:

1. IbrahimZeid,"CAD/CAM TheoryandPractice", TataMcGrawHillPublication,
2. Mikell P. Grover "Automation, Production Systems and Computer-Integrated Manufacturing", Pearson Education, New Delhi.
3. P. Radhakrishnan& S. Subramanyan "CAD/CAM/CIM" Willey Eastern Limited New Delhi.
4. Onwubiko, C., "Foundation of Computer Aided Design", West Publishing Company. 1989
5. R.W.Heine, C. R.Loper and P.C.Rosenthal, *Principles of Metal Casting*, McGraw Hill, Newyork, 1976.
6. J. H.Dubois And W. I.Pribble, *Plastics Mold Engineering Handbook*, Van NostrandReihnhold, New York, 1987.
7. N. K. Mehta, Machine tool design, Tata Mcgraw-hill, New Delhi, 1989.
8. Geoffrey Boothroyd, Peter Dewhurst and Winston Knight, Product Design for Manufacturing and Assembly, 2nd Edition

9. C. Howard, *Modern Welding Technology*, Prentice Hall, 1979.
10. Grieves, Michael, Product Lifecycle Management, McGraw-Hill, 2006. ISBN 0071452303
11. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realization, SpringerVerlag, 2004. ISBN 1852338105

Automobile Engineering

BTAPE504D	Automobile Engineering	PEC 2	3L-0T-0P	Audit

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Identify the different parts of the automobile.
CO2	Explain the working of various parts like engine, transmission, clutch, brakes etc.,
CO3	Demonstrate various types of drive systems.
CO4	Apply vehicle troubleshooting and maintenance procedures.
CO5	Analyze the environmental implications of automobile emissions. And suggest suitable regulatory modifications.
CO6	Evaluate future developments in the automobile technology.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	1	2		2		1						
CO3	1	1		1	1							
CO4	2			3	1							

CO5		2			1	1	2					
CO6	1		2			2						

Course Contents:

Unit 1: Introduction
Vehicle specifications, Classifications, Main components of automobile and articulated vehicles; Engine-cylinder arrangements, Power requirements, Tractive efforts and vehicle performance curves.

Unit 2: Front Axle and Steering System
Functions of front axle, Types of front axle, Construction, Stub axle and Wheel bearing, Front wheel steering Geometry – castor, Camber, King pin inclination, toe-in, toe-out, Centre point Steering, Self-returning property, Adjusting and checking of front wheel geometry, Ackerman and Davis steering linkages, Steering system layout, Steering gear boxes.

Unit 4: Wheels and Tyres
Basic requirements of wheels and tyres, Types of road wheels, Construction of wheel assembly, wheel balancing, Tyre construction, material, types, tubeless, cross ply radial type, tyre sizes and designation, Aspect ratio, tyre trade pattern, tyre valve, Tyre inflation pressure, safety precautions in tyres, Tyre rotation and matching, Types of Tyre wear and their causes, Selection of tyres under different applications, tyre retreating hot and cold, factors affecting tyre performance.

Unit 3: Vehicle Safety Systems
Introduction, Electronic stability program system operation, overview, rollover mitigation system overview, active safety and passive safety, latest trends in traffic system for improved road safety, head restraints, introduction to the type of safety glass and their requirements, types of different mirrors and their location.

Unit 5: Electrical Systems
Construction, operation and maintenance of lead acid batteries, Battery charging system, Principle and operation of cutout and regulators, Starter motor, Bendix drive, Solenoid drive, Magneto-coil and solid stage ignition systems, Ignition timing.

Vehicle Testing and Maintenance
Need of vehicle testing, Vehicle tests standards, Different vehicle tests, Maintenance: trouble shooting and service procedure, over hauling, Engine tune up, Tools and equipment for repair and overhauling, Pollution due to vehicle emissions, Emission control system and regulations.

Texts:

1. KripalSingh, “Automobile Engineering”, Vol. I and II,StandardPublishers.
2. G. B. S. Narang, “Automobile Engineering”, DhanpatRai and Sons.

References:

1. Joseph Heitner, “Automotive Mechanics”, East-West Press.
2. W. H. Crouse, “Automobile Mechanics”, Tata McGraw Hill Publishing Co.
3. “Motor Vehicles”, Newton, Steed and Garrot, 13th Edition, Butterworth London
4. “Vehicle and Engine Technology”, Heisler, Second Edition SAE International

Publication.
5. "Advanced Vehicle Technology", Heisler,Second Edition SAE International Publication.
6. "The Automotive Chassis", J. Reimpell H. Stoll, J.W. Betzler, SAE International Publication.
7. Newton, Steed &Garrot, "Motor Vehicles", 13th Edition, Butterworth London
8. A. W. Judge, "Modern Transmission", Chapman & Hall Std., 1989
9. Chek Chart, "Automatic Transmission", A Harper & Raw Publications
10. J. G.Giles, "Steering, Suspension &Tyres", – Lliffe Book Ltd., London
11. W. Steed, "Mechanics of Road Vehicles", Lliffe Book Ltd
12. Heisler, "Vehicle and Engine Technology", Second Edition, SAE International Publication

Open Elective-I

Solar Energy

BTMOE505A	OEC1	Solar Energy	3-0-0	3 credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Describe measurement of direct, diffuse and global solar radiations falling on horizontal and inclined surfaces.
CO2	Analyze the performance of flat plate collector, air heater and concentrating type collector.
CO3	Understand test procedures and apply these while testing different types of collectors.
CO4	Study and compare various types of thermal energy storage systems.
CO5	Analyze payback period and annual solar savings due to replacement of conventional systems.
CO6	Design solar water heating system for a few domestic and commercial applications.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1											
CO2	1	2				1						
CO3	2			1	1		2					
CO4	1	1										
CO5		2			1							

CO6			2	3		1	1					

Course Contents

Unit 1: Solar Radiation

Introduction, spectral distribution, solar time, diffuse radiation, Radiation on inclined surfaces, measurement of diffuse, global and direct solar radiation.

Unit 2: Liquid Flat Plate Collectors

Introduction, performance analysis, overall loss coefficient and heat transfer correlations, collect or efficiency factor, collect or heat removal factor, testing procedures.

Unit 3: Solar Air Heaters

Introduction, types of air heater, testing procedure.

Unit 4: Concentrating Collectors

Types of concentrating collectors, performance analysis

Unit 5: Thermal Energy Storage and Economic Analysis

Introduction, sensible heat storage, latent heat storage and thermochemical storage

Solar Pond: Solar pond concepts, description, performance analysis, operational problems.

Economic Analysis

Definitions, annular solar savings, payback period.

Texts:

1. J. A. Duffie, W. A. Beckman, “Solar Energy Thermal Processes”, John Wiley, 1974.
2. K. Kreith,J. F. Kreider, “Principles of Solar Engineering”, Tata McGrawHill Publications, 1978.

References:

1. H. P. Garg, J. Prakash, “Solar Energy: Fundamentals and Applications”, Tata McGraw Hill Publications, 1997.
2. S. P. Sukhatme, “Solar Energy Principles of Thermal Collection and Storage”, Tata McGraw Hill Publications, 1996.

Renewable Energy Sources

BTMOE505B	OEC1	Renewable Energy Sources	3-0-0	Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Explain the difference between renewable and non-renewable energy
CO2	Describe working of solar collectors
CO3	Explain various applications of solar energy
CO4	Describe working of other renewable energies such as wind, biomass

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	3		2	3	3	3	2	2		2
CO2	1	1	3	1	2	3	3	3	2	2		2
CO3	2	1	1				3	2		1		2
CO4	3	3			2	3	3	2				1

Course Contents:

Unit1: Introduction

Energy resources, Estimation of energy reserves in India, Current status of energy conversion technologies relating to nuclear fission and fusion, solar energy.

Unit2: Solar Radiations

Spectral distribution, solar geometry, Attenuation of solar radiation in Earth's atmosphere, Measurement of solar radiation, Properties of opaque and transparent surfaces.

Unit3: Solar Collectors

Flat Plate Solar Collectors**:** Construction of collector, material, selection criteria for flat plate collectors, testing of collectors, Limitation of flat plate collectors, Introduction to ETC.

Concentrating type collectors**:** Types of concentrator's advantages, paraboloid, parabolic trough, Heliostat concentrator, Selection of various materials used in concentrating systems, tracking.

Unit4: Solar Energy Applications

Air/ Water heating, Space heating/cooling, solar drying, and solar still, Photo-voltaic conversion.

Unit5: Wind Energy and Biomass and Other Renewable Energy Sources

Types of wind mills, Wind power availability, and wind power development in India. Evaluation of sites for bio-conversion and bio-mass, Bio-mass gasification with special reference to agricultural waste.

Other Renewable Energy Sources: Tidal, Geo-thermal, OTEC; Mini/micro hydro-electric, Geo-thermal, Wave, Tidal System design, components and economics.

Texts:

1. ChetansinghSolanki, "RenewableEnergyTechnologies",PrenticeHallofIndia, 2008.

References:

1. S. P. Sukhatme, "SolarEnergy:PrinciplesofThermalCollectionandStorage", Tata McGrawHill Publications,NewDelhi,1992.
2. G. D.Rai, "SolarEnergyUtilization",KhannaPublisher,Delhi,1992.

Human Resource Management

BTMOE505C	OEC1	Human Resource Management	3-0-0	3 Credits

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week	Audit Course

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Describe trends in the labor force composition and how they impact human resource management practice.
CO2	Discuss how to strategically plan for the human resources needed to meet organizational goals and objectives.
CO3	Define the process of job analysis and discuss its importance as a foundation for human resource management practice
CO4	Explain how legislation impacts human resource management practice.
CO5	Compare and contrast methods used for selection and placement of human resources.
CO6	Describe the steps required to develop and evaluate an employee training program
CO7	Summarize the activities involved in evaluating and managing employee performance.
CO8	Identify and explain the issues involved in establishing compensation systems.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1					2						1	
CO2											3	
CO3										2		
CO4								2		2		
CO5									2	3		
CO6										1		3

CO7										2	2	
CO8											2	

Course Contents:

Unit1: Introduction to Human Resource Management
Concept of management, concept of human resource management, personnel to human resource management, human resource management model, important environmental influences like government regulations, policies, labor laws and other legislation. Acquisition of human resources: Human resource planning, Demand for man power, Weaknesses of manpower planning, job analysis, job specification, recruitment sources, recruitment advertising, the selection process, selection devices, equal opportunities: Indian and foreign practices, socializing then ewemployee

Unit2: Development of Human Resources
Employee Training and Management Development: Training, Training and Learning,
Identification of training needs, training methods, Manager Development, Methods for developing managers, evaluating training effectiveness
Career Development: Concept of career, value of effective career development, external versus internal dimensions to a career, career stages, linking career dimensions with stages

Unit3: Motivation of Human Resources
Definition of motivation, Nature and Characteristics of Motivation, Theories of motivation: Maslow's Need Hierarchy Theory, Drucker Theory, Likert Theory, Herzberg Two Factor Theory, McClell and Theory, McGregor Theory X and Y, etc., Psychological approach.
Job Design and Work Scheduling: Design, Scheduling and Expectancy Theory, Job characteristics model, job enrichment, job rotation, work modules, flex-time, new trends in work scheduling.

Unit4: Performance Appraisal
Performance appraisal and expectancy theory; appraisal process, appraisal methods, factors that can destroy appraisal.
Rewarding the Productive Employee: Rewards and expectancy theory, types of rewards, qualities of effective rewards, criterions for rewards.

Unit5: Maintenance of Human Resources and Labor Relations
Compensation Administration: Concept of Compensation Administration, Job evaluation, Pay structures, Incentives compensation plans.
Benefits and Services Benefits: Something for everybody, Services, Trends in benefits and services.
Discipline: Concept of Discipline, types of discipline problems, general guidelines, disciplinary action, employment-at-will doctrine, disciplining special employee groups Safety and Health: safety programs, health programs, stress, turn out.

Labor Relations
Unions, Major labor legislation, goals of group representation.
Collective Bargaining: Objectives, scope, participants of collective bargaining, process of collective bargaining, trends in collective bargaining
Research and the future: What is research? Types of research, why research inhuman resource management, Secondary sources: where to look it up, Primary sources: relevant research methods, current trends and implications for human resource management.

Texts:
David A. DeCenzo,StephenP. Robbins,
"Personnel/HumanResourcesManagement",PrenticeHallofIndiaPvt. Ltd,3rd edition,2002.
TrevorBolton, "AnIntroductiontoHuman Resource Management", InfinityBooks, 2001.

References:

EllenE.Kossek, "HumanResourceManagement–TransformingtheWorkplace",InfinityBooks,2001.
G.S.Batra, R.C.Dangwal, "HumanResourceManagementNewStrategies",
DeepandDeepPublicationsPvt.Ltd.,2001.
D.M.Silvera, "HRD: TheIndianExperience",NewIndiaPublications,2nd edition,1990.

Product Design Engineering

BTMOE505D	OEC1	Product Design Engineering - I	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hr/Week	Continuous Assessment: 60 Marks End Semester Exam: 40 Marks

- **Pre-requisites:** Knowledge of Basic Sciences, Mathematics and Engineering Drawing
- **Design Studio/Practical:** 2 hrs to develop design sketching and practical skills
- **Continuous Assessment:** Progress through a product design and documentation of steps in the selected product design
- **End Semester Assessment:** Product design in studio with final product specification

Course Outcomes: At the end of the course, students will be able to

1. Create simple mechanical designs
2. Create design documents for knowledge sharing
3. Manage own work to meet design requirements
4. Work effectively with colleagues

Course Contents:

Unit 1: Introduction to Engineering Product Design

Trigger for Product/Process/System, Problem solving approach for Product Design, Disassembling existing product(s) and understanding relationship of components with each other, Sketching of components, identifying materials and their processing for final product, fitting of components, understanding manufacturing as scale of the components, Reverse engineering concept, case studies of products in markets, (or in each discipline), underlying principles, Case studies of product failures, Revival of failed products, Public/Society's perception of products, and its input into product design.

Unit 2: Ideation

Generation of ideas, Funneling of ideas, Short-listing of ideas for product(s) as an individual or group of individuals, Sketching of products, Market research for need, competitions, Scale and cost, Initial specifications of products.

Unit 3: Conceptualization

Designing of components, Drawing of parts and synthesis of a product from its component parts, Rendering the designs for 3-D visualization, Parametric modelling of product, 3-D visualization of mechanical products, Detail engineering drawings of components.

Unit 4: Detailing

Managing assembling, product specifications – data sheet, Simple mechanical designs, Workshop safety and health issues, Create documents for the knowledge sharing.

- **Hands-on Activity Charts for Use of Digital Tools:**

		No. of hrs
Activity 1	Learn the basic vector sketching tools	2
Activity 2	General understanding of shading for adding depth to objects. Understanding of editing vectors	2
Activity 3	Begin developing a thought process for using digital sketching	3
Activity 4	Create a basic shape objects sphere, box cylinders	3
Activity 5	Create automotive wheel concepts	3
Activity 6	Understanding navigation and data panel interface	2
Activity 7	Solid and surface modelling, rendering 3-D models	4
Activity 8	Product market and product specification sheet	3
Activity 9	Documentation for the product	2

Reference:

1. Model Curriculum for “Product Design Engineer – Mechanical”, NASSCOM (Ref. ID: SSC/Q4201, Version 1.0, NSQF Level: 7)
2. Eppinger, S., & Ulrich, K.(2015). Product design and development. McGraw-Hill Higher Education.
3. Green, W., & Jordan, P. W. (Eds.).(1999).Human factors in product design: current practice and

future trends. CRC Press.
4. Sanders, M. S., & McCormick, E. J. (1993). Human factors in engineering and design. McGRAW-HILLbookcompany.
5. Roozenburg, N. F., &Eekels, J. (1995). Product design: fundamentals and methods (Vol. 2). John Wiley & Sons Inc.
6. Lidwell, W., Holden, K., & Butler, J.(2010). Universal principles of designs,revised and updated: 125 ways to enhance usability, influence perception, increase appeal, make better design decisions, and teach through design. Rockport Pub.

Metrology and Quality Control

BTPC6	PCC 11	Metrology and Quality Control	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Identify techniques to minimize the errors in measurement
CO2	Identify methods and devices for measurement of length, angle, and gear and thread parameters, surface roughness and geometric features of parts.
CO3	Choose limits for plug and ring gauges.
CO4	Explain methods of measurement in modern machineries
CO5	Select quality control techniques and its applications
CO6	Plot quality control charts and suggest measures to improve the quality of product and reduce cost using Statistical tools.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				3								2
CO2		2	2		2							
CO3			2	3	2							
CO4						3						
CO5	1					2		3	3		3	2

CO6	1					2		3	3		2	2

Course Contents:

Unit 1: Measurement Standard and Comparators [07 Hours]

Measurement Standard, Principles of Engineering Metrology, Line end, wavelength, Traceability of Standards. Types and Sources of error, Alignment, Slip gauges and gauge block, Linear and Angular Measurement (Sine bar, Sine center, Autocollimator, Angle Décor and Dividing head), Calibration. Comparator: Mechanical, Pneumatic, Optical, Electronic (Inductive), Electrical (LVDT).

Unit 2: Interferometry and Limits, Fits, Tolerances [07 Hours]

Principle, NPL Interferometer, Flatness measuring of slip gauges, Parallelism, Laser Interferometer, Surface Finish Measurement: Surface Texture, Measuring Surface Finish by Stylus probe, Tomlinson and Talysurf, Analysis of Surface Traces: Methods.

Design of Gauges: Types of Gauges, Limits, Fits, Tolerance; Terminology for limits and Fits. Indian Standard (IS 919-1963) Taylor's Principle.

Unit 3: Metrology of Screw Thread [07 Hours]

Gear Metrology: Gear error, Gear measurement, Gear Tooth Vernier; Profile Projector, Tool marker's microscope. Advancements in Metrology: Co-ordinate Measuring Machine, Universal Measuring Machine, Laser in Metrology.

Unit 4: Introduction to Quality and Quality Tools [07 Hours]

Quality Statements, Cost of Quality and Value of Quality, Quality of Design, Quality of Conformance, Quality of Performance, Seven Quality Tools: Check sheet, Flow chart, Pareto analysis, cause and effect diagram, scatter diagram, Brain storming, Quality circles.

Unit 5: Total Quality Management and Statistical Quality Control [07 Hours]

Quality Function Deployment, 5S, Kaizan, Kanban, JIT, Poka yoke, TPM, FMECA, FTA, Zero defects.

Statistical Quality Control: statistical concept, Frequency diagram, Concept of Variance analysis, Control chart for variable & attribute, Process Capability.

Acceptance Sampling**:** Sampling Inspection, sampling methods.Introduction to ISO 9000**:** Definition and aims of standardizations, Techniques of standardization, Codification system.

Texts:

1. I. C. Gupta, "Engineering Metrology", Dhanpatand Rai Publications, New Delhi, India.
2. M. S. Mahajan, "Statistical Quality Control", Dhanpat and Rai Publications.

References:

1. R. K. Jain, "Engineering Metrology", Khanna Publications, 17th edition, 1975.
2. K. J. Hume, "Engineering Metrology", McDonald Publications, 1st edition, 1950.
3. A. W. Judge, "Engineering Precision Measurements", Chapman and Hall, London, 1957.

4. K. L. Narayana, "Engineering Metrology", Scitech Publications, 2nd edition.
5. J. F. Galyer, C. R. Shotbolt, "Metrology for Engineers", Little-hampton Book Services Ltd., 5th edition, 1969.
6. V. A. Kulkarni, A. K. Bewoor, "Metrology & Measurements", Tata McGraw Hill Co. Ltd., 1st edition, 2009.
7. AmitavaMitra, "Fundamental of Quality Control and Improvement", Wiley Publication.
8. V. A. Kulkarni, A. K. Bewoor, "Quality Control", Wiley India Publication, 01st August, 2009.
9. Richard S. Figliola, D. E. Beasley, "Theory and Design for Mechanical Measurements", Wiley India Publication.
10. E. L. Grant, "Statistical Quality Control", Tata McGraw Hill Publications.

J. M. Juran, "Quality Planning and Analysis", Tata McGraw Hill Publications.

Production Engineering Lab-III

BTPCL506	PCC11	**Production Engineering Lab III**	0-0-4	2Credit

Practical Scheme:	**Examination Scheme:**
Practical: 4hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

List of Practical's/Experiments/Assignments (Any 6 from Group-A and Any 4from Group-B)

Group-A (Production Process Lab)

1. Making a job with a process plan involving plain, step and taper turning as well thread cutting as operations on a Centre lathe.
2. Preparation of process planning sheet for a job including operations such as milling, drilling and shaping.
3. Making a spur gear using universal dividing head on milling machine.
4. Making a simple component by sand casting using a split pattern.
5. Cutting of a steel plate using oxyacetylene flame cutting /plasma cutting.
6. Making a butt joint on two stainless steel plates using TIG/MIG Welding.
7. An experiment on shearing operation.
8. An experiment on blanking operation.
9. An experiment on drawing operation

10. Arc Welding.
11. Non Destructive Testing: Magnetic Inspection Testing
12. Non Destructive Testing: Ultrasonic Testing
13. Determine Roll pass scheduling for Blooming Mill and Drawing of Grooved Rolls.
14. Design Simple Die for Cutting Operation.
15. Design and Drawing of Bending/Forming/Coining Dies.
16. Assignment on Sand Casting.
17. Design of Forging Dies.
18. Assignment on Extrusion Process.

Group-B (Design of Machine Element Practice)

1. The term work shall consist of two design projects based on the syllabus of Design of machine Element. Each design project shall consist of two imperial size sheets- one involvingassemblydrawingswithapartlistandoveralldimensionsandothersheetinvolvingdrawingsofindividualcomponents.Manufacturingtolerances,surfacefinishsymbolsandgeometrictolerancesshouldbespecified,wherevernecessary,soastomake it working drawing
2. A designreportgivingallnecessarycalculationsforthedesignofcomponentsandassemblyshould be submitted in a separate file.

Two assignments based on topics of syllabus of Design of machine Element.

IT – 2 Evaluation

PROJ-2	BTPI408 (IT – 2)	IT – 2 Evaluation	-	-	-	-	-	100	100	1

Semester-VI

Machine Tools and Metal Cutting

BTPC601	PCC 12	Machine Tools and Metal Cutting	3-1-0	4Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Objectives: To make student aware of tool geometry, tool signature, and mechanics of chip formation, types of chip, tool wear, and surface finish and need of cutting fluids, machininabilty of the materials. Study of various features and capabilities of various machine tools, machining time calculation will help in selection of appropriate machine tool for a particular application.

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Classify various machine tools and estimate machining time.
CO2	Calculate the cutting forces in orthogonal and oblique cutting.
CO3	Evaluate the machinability of materials.
CO4	Identify the abrasive processes.
CO5	Classify the different precision machining processes.
CO6	Design jigs and fixtures for given application.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	1				1							
CO2	1			1	1							
CO3	1			1	1							
CO4	1				1							
CO5	1				1							
CO6	1		1		1							1

Course Contents:

Unit1:ClassificationofMetalRemovalProcessesandMachineTools
Introduction to ManufacturingandMachining,Basicworking principle,configuration, specification and classification of machine tools, Construction, working principle and applicationsofshaping,planningandslottingmachines,Useof various attachmentsinMachine Tools,Estimationofmachiningtime

Unit2:MechanicsofMachining(MetalCutting)
Geometry ofsinglepointcuttingtools,Mechanismofchipformation,Orthogonalandobliquecutting,Useofchipbreakerinmachining,MachiningforcesandMerchant'sCircleDiagram(MCD), Analytical and Experimental determination of cutting forces, Dynamometers for measuringcuttingForces,Cuttingtemperature: causes,effects,assessmentandcontrol,Controlofcuttingtemperatureandcuttingfluidapplication

Unit3:Machinability
ConceptofMachinabilityandits improvement,Failureofcuttingtoolsandtoollife,CuttingToolMaterialsofcommonuse,AdvancedCuttingToolMaterials

Unit4:AbrasiveProcesses(GrindingandSuperFinishing)
Basicprinciple,purposeandapplicationofgrinding,Selectionofwheelsandtheirconditioning, Classificationofgrindingmachinesandtheiruses,Superfinishingprocesses,Honing,LappingandSuper finishing

Unit5:Gear and thread manufacturing
Production ofscrewthreadsbyMachining,Rolling and Grinding, Manufacturing ofGears, Broaching–PrinciplesandApplications

Introduction to Jigs and Fixtures
Role and importance of jigs and fixture, Principle of location and clamping, Locating, Supporting and clamping elements, Applicationoftypicaljigsandfixtures.

Texts:

1. P.N.Rao," ManufacturingTechnology-MetalCuttingandMachineTools",Vol.II,TataMcGrawHillPublishingCo.Ltd,NewDelhi,2nd edition,2002.

2. Amitabha Bhattacharyya, G. C. Sen, "Principle of MetalCutting", New Central Book Agency,1969.
3. M.C.Shaw,"TheoryofMetalCutting",OxfordandI.B.H.Publishing,1st edition,1994.
4. P.H.Joshi,"JigsandFixtures",TataMcGrawHillPublishingCo., NewDelhi.

References:

1. MilkellP.Groover," FundamentalsofModernManufacturing: Materials,Processes, andsystems",JohnWileyandSons,NewJersey, 4th edition,2010.
2. SeropeKalpakjianandStevenR.Schmid,"ManufacturingEngineeringandTechnology", AddisonWesleyLongman(Singapore)Pte.IndiaLtd., 4thedition,2000.
3. GeoffreyBoothroyd,WinstonKnight,"FundamentalsofMachiningandMachineTools", TaylorsandFrancis,3rd edition,2006.
4. EdwardG.Hoffman,"JigsandFixturesDesign",CengageLearning,5th edition,2004.
5. Paul DeGarmo, J.T. Black, RonaldA. Kohser, " Materials and Processes in Manufacturing",Wiley,10th edition,2007.
6. www.nptel.com, IIT Kharagpur, Manufacturing ProcessesI.

CAD/CAM/CIM

BTPC602	PCC 13	CAD/CAM/CIM	3-1-0	4Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	List and describe the various input and output devices for a CAD work station
CO2	Carry out/calculate the 2-D and 3-D transformation positions (Solve problems on 2-Dand 3-D transformations)
CO3	Describe various CAD modeling techniques with their relative advantages and limitations
CO4	Describe various CAD modeling techniques with their relative advantages and limitations
CO5	Develop NC part program for the given component, and robotic tasks
CO6	Describe the basic Finite Element procedure
CO7	Explain various components of a typical FMS system, Robotics, and CIM
CO8	Classify parts in part families for GT
CO9	Describe and differentiate the CAPP systems

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											1
CO2	3	2	1		2							1
CO3	1		1									1

CO4	3											1
CO5	1	3	3		1							1
CO6	3	1	1		1							1
CO7	3											1
CO8	3	1	2	3	1							1
CO9	2	1										1

Course Contents:

Unit1: ComputerAidedDesign(CAD)

Hardware requiredforCAD:Interactiveinput output devices,Graphicssoftware:general requirementsandgroundrules,2 –DcurveslikeLine,Circle,etc.andtheiralgorithms, 2-D and 3-DtransformationssuchasTranslation,Scaling,RotationandMirror

Unit2: BezierandB-splinesCurves

EquationsandApplications, window andviewportclippingalgorithms,3-Dgeometries, CSG, B-rep, wireframe,surfaceandsolidmodelingandtheirrelativeadvantages,limitationsandapplications.

Unit3: ComputerAidedManufacturing(CAM)

NumericalControl, ElementsofaNCsystem,StepsinNCbasedmanufacturing,Point to point,straightlineandcontouringcontrol,ManualandComputerAssistedPartProgramming,NCand APT programming, Adaptive control, Distributed Numerical Control.

Unit4: FiniteElementMethods

Introduction,Typesofelements,Degreesoffreedom,Fieldvariable,Shapefunction, Boundary conditions,Meshing,Nodaldisplacements,Plainstressandplainstrain problems,1-D,2-Dand3-Dproblems,Static,dynamicandthermalanalysis,Preprocessors –solvers–postprocessor.

Unit5: FlexibleManufacturingSystem

Introduction,ComponentsofFMS,GroupTechnology,Partclassificationandfamilies,Compositepart ,Typesof FMSlayouts,AdvantagesofFMS

Robotics: Robotconfigurations,

Drivesforrobots,Sensorsusedinrobotics,Programmingtechnique,Programminglanguages,Applicat ions,Latestdevelopmentin robotics

ComputerAidedProcessPlanning

Introduction, RetrievalandGenerativeCAPPsystems, generationofMachiningData.

ComputerIntegratedManufacturing:

Introduction,Typesofdata,Typesofinterfaces,Computernetworkstructures, Computerizedproductionmanagementsystems,Inventorymanagement,MRP,Operationscheduling, Processmonitoring,Computeraidedqualitycontrol,Testing/Inspectionmethods.

Texts:

IbrahimZeid,“CAD/CAMTheoryandPractice”, TataMcGrawHillPublication,

M. P. Grover,Zimmer,“CAD/CAM/CIM”, PrenticeHallIndia.

Elective-III

Robotics & Automation

BTPPE603A	PEC3	Robotics& Automation	3-1-0	4Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	List the various components of a typical Robot, grippers, sensors, drive system and describe their functions
CO2	Calculate the word to joint and joint to word coordinates using forward and reverse transformations
CO3	Calculate the gripper forces, drive sizes, etc.
CO4	Develop simple robot program for tasks such as pick and place, arc welding, etc. using some robotic language such as VAL-II, AL, AML, RAIL, RPL, VAL
CO5	Evaluate the application of robots in applications such as Material Handling, process operations and Assembly and inspection
CO6	Discuss the implementation issues and social aspects of robotics

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents:

Unit 1: Introduction
Various basic components of a Robotic system, various configurations, work envelopes, Manipulators, sensors, controllers, etc.

Unit 2: Mechanical System in Robotics
Motion conversion, Kinematic chains, position analysis, forward and backward transformations, natural and joints pace coordinates.

Unit 3: Drives for Robot
Electrical drives**,** Stepper motor, DC motors, AC motors, hydraulic and pneumatic drives, hybrid drives, drive selection for robotics joints.

Unit 4: Sensors in Robotics
Position sensor, velocity sensor, proximity sensors, touch sensors, force sensors, etc.

Robot Programming
Path planning, Leadthrough(manual and powered) programming, teach pendant mode, programming languages, AL, AML, RAIL, RPL, VAL pmentin robotics

Unit 5: Artificial Intelligence for Robots: Knowledge Representation, Problem representation and problem solving, search techniques in problem solving

Robot Applications
Application of robot in: Material handling, assembly and inspection, process operations, etc.

Texts:
1. M. P. Grover, “Industrial Robotics: Technology, Programming and Applications”, Tata McGraw Hill Publication.

References:
1. Saeed B. Niku, “Introduction to Robotics, Analysis, Systems, Applications”, Pearson Education.
2. Richard D. Klafter, “Robotic Engineering: An Integrated Approach”, Prentice Hall of India.

Assembly Planning and Management

BTPPE603B	PEC3	Assembly Planning and Management	3-1-0	4Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Objectives: To gain an understanding and interest in the assembly line design practices prevalent in industry and ability to recognize situations in an assembly system environment those suggest the use of certain quantitative methods to assist in decision making. To learn how to think about, approach, analyze, and solve assembly system problems using people skills (predominantly) and technology.

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Illustrate key characteristics and types of assembly.
CO2	Classify the various methods of assembly sequence planning.
CO3	Outline the concept of assembly line design.
CO4	Solve simple assembly line balancing problems.
CO5	Formulate and solve generalized assembly line balancing problems.
CO6	Illustrate need and approaches for reconfiguration of assembly lines.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1				1							
CO2	1				1							
CO3	1	1			1							
CO4	1				1		1					
CO5	1				1		1					
CO6	1				1	1						

Course Contents:

Unit 1: Introduction to Assembly Planning

Assembling a product, manual and automatic assembly, robotic assembly, Liaison diagram, assembly process, key characteristics of assembly, variation risk and its management.

Unit 2: Assembly Sequence Planning

Introduction, assembly sequence design process, Bourjault method of generating all feasible sequences, cutest method, stability of subassemblies, softwares

Unit 3: Assembly Line Design

Process of Assembly Line Design (ALD), components of ALD, consideration of equipment's, buffers etc. Introduction to assembly line balancing and defining assembly line balancing problem using precedence diagrams.

Unit 4: Simple Assembly Line Balancing Problem (SALBP)

Performance Characteristics, types of SALBP, optimal solution methods for SALBP, heuristics and meta-heuristics, introduction to Genetic Algorithm, applying simple genetic algorithmic approach to SALBP.

Unit 5: Generalized Assembly Line Balancing Problem (GALBP)

Considerations leading to GALBP, formulation and solution approaches for a few types of GALBP such as assignment restrictions, mixed model ALBP, U-line ALBP, parallelization, etc.

Reconfiguration

Need and importance of reconfiguration/rebalancing, approaches for reconfiguration.

Texts and References:

1. Daniel E. Whitney, "Mechanical Assemblies", Oxford University Press, 2004

2. Mikell P. Groover, "Automation: Production Systems and Computer Integrated Manufacturing", Second edition, Prentice Hall of India, 2002

IC Engines

BTMPE603A	PEC3	IC Engines	3-0-0	3Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Applied Thermodynamics – I

Course Outcomes: At the end of the course, students will be able to

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents:

Unit 1: Fundamentals of IC Engines

Applications, nomenclature, engine components, Engine classification, two and four stroke cycle engines; fundamental difference between SI and CI engines; valve timing diagrams.

Power Cycles: Air standard Otto, Diesel and Dual cycles; Valve timing diagrams, Fuel-Air cycles and deviation of actual cycles from ideal cycles.

Unit 2: Combustion

Introduction, important qualities and ratings of SI Engines fuels; qualities and ratings of CI Engine fuels.

Combustion in S.I. Engines, flame speed, ignition delay, normal and abnormal combustion, effect of engine variables on flame propagation and ignition delay, Combustion in C.I. Engines, combustion of a fuel drop, stages of combustion, ignition delay, combustion knock; types of SI and CI Engine combustion chambers.

Unit 3: Various Engine Systems and Engine Testing and Performance

Starting systems, fuel supply systems, engine cooling system, ignition system, engine friction and lubrication systems, governing systems.

Engine Testing and Performance of SI and CI Engines

Parameters, Type of tests and characteristic curves.

Super charging in IC Engine: Effect of attitude on power output, types of supercharging.

Engine Emissions and control: Pollutants from SI and CI engines and their control, emission regulations such as Bharat and Euro.

Unit 4: Alternate fuels

Need for alternative fuels, applications, various alternate fuels etc

Gaseous Fuels, Alcohols, Biodiesels, vegetable oil extraction, Trans-esterification process, properties of alternative fuels and fuel blends.

Fuel Cell Technology: Operating principles, Types, construction, working, application, advantages and limitations.

Unit 5: Layout of Electric vehicle and Hybrid vehicles

Advantages and drawbacks of electric and hybrid vehicles, System components, Electronic control system – Different configurations of Hybrid vehicles, Power split device. High energy and power density batteries – Basics of Fuel cell vehicles

Texts&References:

1. V. Ganeshan, “Internal Combustion Engines”, Tata McGraw Hill Publications, New Delhi, 3rd edition.
2. J. B. Heywood, “Internal Combustion Engine Fundamentals”, Tata McGraw Hill Publications, New York, International Edition, 1988.
3. “Alternative Fuels”, Dr. S. S. Thipse, Jaico publications.
4. “IC Engines”, Dr. S. S. Thipse, Jaico publications.
5. “Engine Emissions, pollutant formation”, G. S. Springer and D.J. Patterson, Plenum Press.
6. ARAI vehicle emission test manual.
7. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, “The Biodiesel Handbook”, AOCS Press
8. Champaign, Illinois 2005.
9. Richard L Bechtold P.E., Alternative Fuels Guide book, Society of Automotive Engineers,
10. 1997, ISBN 0-76-80-0052-1.

Transactions of SAE on Biofuels (Alcohols, vegetable oils, CNG, LPG, Hydrogen, Biogas etc.

Mechanical Vibration

BTMPE603B	PEC3	Mechanical Vibration	3-0-0	Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Theory of Machines - II

Course Outcomes: At the end of the course, students will be able to:

CO1	Understand the cause and effect of vibration in mechanical system
CO2	Formulate governing equation of motion for physical system
CO3	Understand role of damping, stiffness and inertia in mechanical system
CO	Analyze rotating system and calculate critical speeds
CO5	Estimate the parameters of vibration isolation system
CO6	Estimate natural frequencies and mode shapes of continuous system

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	2	1	1					2
CO2	3	3	2	1	1							2
CO3	3	2	2	1	1							2
CO4	3	3	2	2	2							2
CO5	3	3	2	2	2		3					2
CO6	3	3	3	2								2

Course Contents:

Unit 1: Single DOF- Free Vibrations

Basic concepts: Causes and effect of vibrations, practical applications, harmonic and periodic motions, vibration terminology, vibration model, Equation of motion -natural frequency, Energy method, Rayleigh method, principle of virtual work, damping model, viscously damped free vibration, Oscillatory, non-oscillatory and critically damped motions, logarithmic decrement. Coulomb's damping.

Unit 2: Single DOF- Forced Vibrations

Analysis of linear and torsional system subjected to harmonic force excitation, force transmissibility, Magnification factor, motion transmissibility, vibration isolation, typical isolator and mounts, critical speed of single rotor, undamped and damped.

Unit 3: Two DOF Systems

Introduction, formulation of equation of motion, equilibrium method, lagrangian method, free vibration response, Eigen values and eigen vector, Normal mode and mode superposition, Coordinate coupling, decoupling equation of motion.

Unit 4: Torsional Vibration

Simple system with one or two rotor masses, Multi DOF system: transfer matrix method, geared system, and branched system.

Unit 5: Multi Degree of Freedom System and Continuous Systems

Formulation of equation of motion, free vibration response, natural mode and mode shapes, orthogonality of model vectors, normalization of model vectors, decoupling of modes, model analysis, mode superposition technique. Free vibration response through model analysis. DF

Continuous Systems

Vibration of strings, longitudinal and transverse vibration of rods, transverse vibrations of beams, equation of motions and boundary conditions, transverse vibration of beams, natural frequencies and mode shapes.

Texts:

1. L. Meirovich, “Elements of Vibration Analysis”, Tata McGraw Hill.

References:

1. S. S. Rao, “Mechanical Vibrations”, Pearson education.
2. W. T. Thompson, “Theory of Vibration”, CBS Publisher.

Machine Tool Design

BTMPE603C	PEC3	Machine Tool Design	3-0-0	3Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Machine design and Manufacturing processes-I

Course Outcomes: At the end of the course, students will be able to:

CO1	Understand basic motion involved in a machine tool.
CO2	Design machine tool structures for conventional and CNC machines.
CO3	Design and analyze system for specified speeds and feeds.
CO4	Understand control strategies for machine tool operations.
CO5	Design of rotary and linear drive for machine tools.
CO6	Analyze machine tool structure for design accuracy.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	1	1				1	1	1
CO2	3	1	3	1	2	1	1		1	1	1	1
CO3	2	1	2	1	1	1			1	1	1	1
CO4	2	1	1	1	1	1	1			1	1	1
CO5	3	1	3	1	1	1	1		1	1	1	1
CO6	2	1	2	1	1	1	1		1	1	1	1

Course Contents:

Unit 1: Introduction

Kinematics of different types of machine tools, selection of cutting conditions and tools, calculations of cutting force on single point and multipoint tools, hole machining, calculation of power, accuracy requirements and standards.

Unit 2: Design of Rotary Drives

Design of spindle drives, AC motors with stepped drive, DC and AC variable speed drive motor characteristics and selection, principle of speed controllers, timing belts and other types of transmission belting, closed loop operation of mail drives, rotary indexing drives.

Unit 3: Design of Feed Drives

Feed drive using feed boxes, axes feed drive of CNC drives, DC and AC servomotors, characteristics controllers and their selection, Ball screws and friction guide ways, linear motion systems, design calculation of drives, closed loop operations of feed drive, linear indexing drives.

Unit 4: Control Elements

Single and multi-axis CNC controllers, hydraulic control, Pneumatic control limit switches, proximity switches, sequencing control using hardwired and PLC systems.

Design of machine tool structures: Static and dynamic stiffness, dynamic analysis of cutting process, stability, forced vibration, ergonomics and aesthetics in machine tool design.

Unit 5: Design of Spindle and Spindle Supports and Design of Special Purpose Machines

Function of spindles, design requirements, standard spindle noses, design calculation of spindles, bearing selection and mounting.

Finite elements analysis of machine tool structures: Examples of static, dynamic and thermal analysis and optimization of typical machine tool structure like column and using a finite element analysis package.

Design of Special Purpose Machines

Modular design concepts, standard modules, example of design of typical SPM with CNC, transfer machines.

Texts:

1. N. K. Mehta, “Machine Tool Design”, Tata McGraw Hill Book Co., 1991.
2. P.C. Sharma, “A Textbook of Machine Tools and Tool Design”, S. Chand & Co. Ltd., 1 January 2005.
3. Sen and Bhattacharya, “Principles of Machine Tools”, 1 Jan 2009.
4. YoramKoren, “Computer control of manufacturing systems”, Tata McGraw Hill Education, 2009.

References:

1. Aacherkan, “Machine Tool Design”, Vol. I and Vol. III, Mir Publishers, Moscow,1970.
2. W. L. Cheney, “Details of Machine Tool Design (Classic Reprint)”, Forgotten Books, 20 Sep 2016.
3. Central Machine Tool Institute, “Machine Tool Design Handbook”, Tata McGraw Hill Education, 1st Edition, 16 June 2001.

4. Nicholas Lisitsyn, Alexis V Kudryashov, Oleg Trifonov, Alexander Gavryusin, N Acherkan, Nicholas Weinstein, “Machine Tool Design”, Vol. I, University Press of the Pacific, 20 April 2000.

Automobile Body Design

BTAPE603C	Automobile Body Design	PEC 3	3L-0T-0P	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: (Pre-requisite: Automobile Design)

Course Outcomes: At the end of the course, students will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Domain Related Training (Approx. 40 hrs)

Unit 1:

BIW : Requirement Specification in the Pre-Program Stage, Product Life Cycle & Important Gateways for BIW, Identification of Commodities for BIW, Design Concept & Considerations in BIW, BIW Materials & Grades, GD & T for BIW.

Unit 2:

Sheet Metal Joining – Welds, Adhesives, TWBs. DFMEA, Design Verification – CAE Methods & Gateway supports Part A & B, CAE Analysis – NVH, Crash & Durability, Test Validation &Assessment.

Unit 3:

Manufacturing – Sequence, Welding & Assembly, Future Trends in BIW, BIW: Examples & Case Studies.

Unit 4:

Trims: Requirement Specification in the Pre-Program Stage, Product Life Cycle & Important Gateways for Trims, Identification of Commodities for Trims, Design Requirements &Considerations, Trim Materials in Automotive.

Unit 5:

Design of Plastic Part, DFMEA, Design Verification – CAE Methods & Gateway supports, CAE Analysis – Moldflow, Crash & Durability, Test Validation & Assessment.

Manufacturing Process, Assembly Sequence, Future Trends & Future Material for Trims, Trims: Examples & Case Studies.

Texts:

1. Notes of TATA Technologies
2. Curt Larson, " Datum Principles: Flexible Parts: Applications for Automotive Body-in-White and Interior Trim (Dimensional Management Series Book 1)", Right Tech, Inc., Kindle Edition.
3. Curt Larson, " Datum Principles: Flexible Parts: Applications for Automotive Body-in-White and Interior Trim (Dimensional Management Series Book 2)", Right Tech, Inc., Kindle Edition.

References:

1. VukatoBoljanovic, "Sheet Metal Forming Processes and Die Design", Industrial press Inc., Kindle Edition.
2. R. D. Cook, Concepts and Applications of Finite Element Analysis; John Wiley and Sons, second edition, 1981.
3. K.J. Bathe, Finite Element Method and Procedures; Prentice hall, 1996.
4. IbrahimZeid,"CAD/CAM Theory and Practice", Tata McGraw Hill Publication,
5. J. H.Dubois And W. I.Pribble, *Plastics Mold Engineering Handbook*, Van NostrandReihnhold, New York, 1987.

6. Geoffrey Boothroyd, Peter Dewhurst and Winston Knight, Product Design for Manufacturing and Assembly, 2nd Edition
7. C. Howard, *Modern Welding Technology*, Prentice Hall, 1979.
8. Jesper Christensen and Christophe Bastien, "Nonlinear Optimization of Vehicle Safety Structures: Modeling of Structures Subjected to Large Deformations, Butterworth-Heinemann, Kindle Edition
9. Grieves, Michael, Product Lifecycle Management, McGraw-Hill, 2006. ISBN 0071452303
10. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realization, SpringerVerlag, 2004. ISBN 1852338105

Elective-IV

Production Planning and Control

BTPPE604A	PEC4	Production Planning and Control	3-1-0	4Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Objectives: To gain an understanding and appreciation of the fundamental principles and methodologies relevant to planning, design, operation, and control of production systems. To reinforce analytical skills already learned, and build on these skills to further increase ones "portfolio" of useful analytical tools. To gain ability to recognize situations those suggest the use of certain quantitative methods to assist in decision making and learn how to think about, approach, analyze, and solve production system problems using both technology and skill people.

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Illustrate functions of PPC and basic concepts of product analysis.
CO2	Estimate output for a given data using various forecasting methods.
CO3	Determine the optimal production order quantity for a given data.

CO4	Estimate the machine output and process capacities in a multi-product system.
CO5	Solve the sequencing problems for the given data.
CO6	Estimate the inventory level by various methods for given data.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1				1							
CO2	1			1	1							
CO3	1			1	1						1	
CO4	1			1	1						1	
CO5	1			1	1							
CO6	1			1	1							

Course Contents:

Unit 1: Product Development and Design

Introduction: Functions of PPC, types of production, production consumption cycle, coordination of production decisions. Product Design and Company Policy, Product Analysis: Marketing Aspect, Product Characteristics, Economic Analysis, production Aspect.

Unit 2: Forecasting and Facility Layout

Introduction, Time Series Methods, Casual Methods, Forecast Errors. Facility Layout: Introduction, Flow Systems, Types of Layout: Product, Process, Group Layout, Computerized Layout Planning

Unit 3: Production Order

Purpose of production order, procedure for formulating production order, process outlines, process and activity charts, production master program, operation and route sheet, production order. Batch Production: Quantities in batch production, criteria for batch size determination, minimum cost batch size, production range, maximum profit batch size, maximum return and maximum rate of return economic batch size

Unit 4: Machine Output

Machine output, multi-machine supervision by one operator, machine interference, balancing of machine lines, analysis of process capacities in a multi -product system

Unit 5: Production and Operations Planning

Aggregate Planning, Strategies and techniques for Aggregate Planning, Production Planning in Mass Production Systems and Assembly Line Balancing, Sequencing problems such as 1

machine n jobs, 2 machines n jobs & its extension, m machines 2 jobs, scheduling jobs with random arrivals

Inventory Control

Inventory and its purpose, the relevant costs, selective inventory analysis (ABC analysis), Classical Inventory Model, EOQ with quantity discounts, EOQ for multiple items with constraints on resources, Safety Stock, determining safety stock when usage and lead time vary, Fixed Order Period Inventory Control System

Texts:

1. D.Bedworth and J.E Bailey, "Integrated Production Control: System-management, Analysis and Design", John Wiley, 1983.
2. A.Elsayed and T.O. Boucher, "Analysis and Control of Production Systems", Prentice Hall, 1985.
3. J. R. King, "Production Planning and Control", Pergamon Press, Oxford, 1975.

References:

1. P.F.Bestwick and K.Lockyer, "Quantitative Production Management", Pitman Publications, 1982.
2. A.C.HaxandD.Candea, "Production and Inventory Management", Prentice-Hall, 1984.
3. M.G.Korgaokar, "JIT Manufacturing", Macmillan, 1992.

Flexible Manufacturing Systems

BTPPE604B	PEC4	Flexible Manufacturing Systems	3-1-0	Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Objectives: To understand Flexible Manufacturing Systems, Configurations, Workstations, Control systems, applications and benefits.

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Define FMS, its need, benefits and limitations.
CO2	Outline layout, configuration and optimization of FMS.
CO3	Outline the process of installation, interfacing and monitoring of FMS.
CO4	Propose suitable FMS configuration for a given application.
CO5	Identify AGV, ASRS, transfer and feeding mechanisms in FMS.
CO6	Summarize tool management and monitoring strategies in FMS.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1				1							
CO2	1				1	1						
CO3	1				1	1						
CO4	1				1		1					
CO5	1				1				1			
CO6	1				1				1			1

Course Contents:

Unit 1: Overview of FMS
An overview, need for FMS, classification, benefits and limitations, components of FMS, Flexibility in manufacturing, Building blocks of FMS, FMS control, FMC Vs FMS.

Unit 2: Implementation of FMS
FM system development and implementation of an FMS, planning, description, layout and configuration, analysis and optimization of FMS, organization and information processing in manufacturing.

Unit 3: Software for FMS
Concepts of distributed numerical control, programmable controller's hardware configurations, FMS software, FMS instillation, and computer control of work center and assembly lines, functions of computers, computer process interface, and computer process monitoring.

Unit 4: Modeling and Simulation of FMS
Modeling, simulation and analysis of FMS design, Scheduling and loading of FMS, network, Economic considerations.

Unit 5: Automation in FMS
Automated material handling and storage, automated storage, automated flow lines, methods of work-part transport, transfer mechanisms, auxiliary support equipment, automation of machining operations, introduction and design of automated assembly systems, part feeding devices, automated inspection and testing, contact and noncontact inspection methods.

Tool Management

FMS fixtures, tool management, tool strategies, tool monitoring and fault detection, analysis methods for FMS, FMS development towards factories of the future

Texts/References:

1. D.J.Parish, Flexible Manufacturing Systems, Butter Worth-Heinemann Ltd., Oxford, 1993.

2. M.P.Groover, Automation, Production Systems and Computer Integrated Manufacturing, Prentice Hall of India Ltd., 1989.

3. A.Kusiak, Intelligent Manufacturing Systems, Prentice Hall, Englewood Cliffs, New Jercy, 1990.

4. D.M.Considine, G.D.Considine, Standard Handbook of Industrial Automation, Chapman and Hall, London, 1986.

5. N.Viswanadhan, Y.Narhari, Performance Modeling of Automated Manufacturing Systems, Prentice Hall of India Ltd., 1992.

6. P.G.Ranky , The Design and Operation of FMS, IFS Publishers. UK, 1988.

7. W.W.Luggen , Flexible Manufacturing Cells and Systems, Prentice Hall, Eaglewood Chiffs, New Jercy, 1991.

Process Equipment Design

BTMPE604A	PEC4	Process Equipment Design	3-0-0	Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Understand the factors influencing design of pressure vessel
CO2	Calculate thickness and thickness variation for cylindrical storage tank
CO3	Estimation of thickness for thin and thick wall pressure vessels
CO4	Design of flange and gasket selection for cylindrical pressure vessels
CO5	Selection of various blade and baffle arrangement for agitators
CO6	Design of support for horizontal and vertical vessel

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1		1			1	1	1				1
CO2	2	2	1			1	1	1				1
CO3	2	2	2			1	1	1				1
CO4	2	2	2			1	1	1				1
CO5	2	2	1			1	1	1				1

CO6	2	2	2			1	1	1				1

Course Contents:

Unit 1: Design Considerations for Pressure Vessel

Selection of type of vessel, Methods of fabrication, Effect of fabrication methods, various criteria in vessel design, Economic considerations, Types of process equipment, Constructional requirement and applications. Fabrication and testing, Inspection and non-destructive testing of equipment.

Unit 2: Storage Vessel

Design methods of atmospheric storage vessel: storage of fluids, storage of non-volatile liquids, storage of volatile liquids, storage of gases, Optimum tank proportion, Bottom design, Shell design, Wind girder for open top tank, Rub curb angle, Self-supported roof, Design of rectangular tank,

Unit 3: Pressure Vessel

Unfired process vessel with internal and external pressure, Operating condition, Selection of material, Design condition, Stresses, Design criteria, Design of shell subjected to internal and external pressure, Cylindrical vessel under combined loading,

Design of heads and closures: flat head and formed heads for vessel. Design consideration for rectors and chemical process vessels. Flange facings, Gaskets, Design of flanged joint, Flange thickness, and Blind flanges.

Unit 4: High Pressure Vessel

Design of thick walled high-pressure vessel, Constructional features, Materials for high-pressure vessels, Multilayer vessel with shrink fit construction, Thermal expansion for shrink fitting, stress in multi shell or shrink fit construction, auto frettage, Pre-stressing. Tall vessels and their design, Stress in shell, Determinations of longitudinal stresses, Longitudinal bending stresses due to eccentric loads, Determination of resultant longitudinal stresses.

Unit 5: Agitated Vessel and Support for Pressure Vessel

Type of agitators, Baffling, Power requirement for agitation, Design based on torque and bending moment, Design based on critical speed, Blade design, Hub and key design, Stuffing box and gland design, Turbine agitator design,

Support for Pressure Vessel

Bracket or lug support: Thickness of the base plate, Thickness of web (gusset) plate, Column support for bracket base plate for column or leg support. Skirt Support: Skirt design, Skirt bearing plate, and Anchor bolt design, Design of bolting chair. Saddle Support: Longitudinal bending moment, Stresses in shell at saddle.

Texts:

1. V. V. Mahajani, S. B. Umarji, “Process Equipment Design”, Macmillan Publisher India Ltd.
2. L. E. Brownell, E. H. Young, “Process equipment design”, John Wiley and Sons.
3. C. Bhattacharya, “Introduction to process Equipment Design”.

Reference Book:

1. Dennis Moss, “Pressure Vessel Design Manual”, Elsevier.
2. John F. Harvey, “Theory and Design of Pressure Vessels”, CBS Publication.

Product Life Cycle Management

BTMPE604B	PEC4	Product Life Cycle Management	3-0-0	3Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Objectives: Establishing industry partnerships that guide, support, and validate PLM research and education activities assisting with the integration of PLM into College curricula and facilitating the PLM career opportunities.

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Outline the concept of PLM.
CO2	Illustrate the PDM system and its importance.
CO3	Illustrate the product design process.
CO4	Build the procedure for new product development.
CO5	Classify and compare various technology forecasting methods.
CO6	Outline the stages involved in PLM for a given product.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1				1						1	

CO2	1				1		1				1	
CO3	1		1		1							
CO4	1		1		1						1	
CO5	1				1		1					
CO6	1				1				1			1

Course Contents:

Unit 1: Introduction and strategies to PLM

Need for PLM, opportunities and benefits of PLM, different views of PLM, components of PLM, phases of PLM, PLM feasibility study, PLM visioning, Industrial strategies, strategy elements, its identification, selection and implementation, change management for PLM.

Unit 2: Product Data Management (PDM)

Human resources in product lifecycle, Information, Standards, Vendors of PLM Systems and Components, PDM systems and importance, reason for implementing a PDM system, financial Justification of PDM, barriers to PDM implementation

Unit 3: Product Design

Engineering design, organization and decomposition in product design, product design process, methodical evolution in product design, concurrent engineering, design for 'X' and design central development model. Strategies for recovery at end of life, recycling, human factors in product design. Modeling and simulation in product design.

Unit 4: New Product Development

Structuring new product development, building decision support system, Estimating market opportunities for new product, new product financial control, implementing new product development, market entry decision, launching and tracking new product program, Concept of redesign of product

Unit 5: Technology Forecasting and PLM Software and Tools

Future mapping, invocating rates of technological change, methods of technology forecasting such as relevance trees, morphological methods and mission flow diagram, combining forecast of different technologies, uses in manufacture alternative.

PLM Software and Tools

Product data security. Product structure, workflow, Terminologies in workflow, The Link between Product Data and Product Workflow, PLM applications, PDM applications.

Texts/References:

1. Grieves, Michael, "Product Lifecycle Management", Tata McGraw-Hill, 2006, ISBN 007145230330.
2. Antti Saaksvuori, AnselmiImmonen, "Product Life Cycle Management", Springer, 1st edition, 2003.
3. Stark, John, "Product Lifecycle Management: Paradigm for 21stCentury Product Realization", Springer-Verlag, 2004.
4. Fabio Giudice, Guido La Rosa, "Product Design for the environment-A life cycle approach", Taylor & Francis, 2006.

5. Robert J. Thomas, “NPD: Managing and forecasting for strategic processes”.

Finite Element Method

BTMPE604C	PEC4	Finite Element Method	3-0-0	3Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Understand the basic principle of Finite element methods and its applications
CO2	Use matrix algebra and mathematical techniques in FEA
CO3	Identify mathematical model for solution of common engineering problem
CO4	Solve structural , thermal problems using FEA
CO5	Derive the element stiffness matrix using different methods by applying basic mechanics laws
CO6	Understand formulation for two and three dimensional problems

Mapping of course outcomes with program outcomes

Course	Program Outcomes

Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1		1				1		1	1
CO2	2	3	2	1	2	1		1			2	1
CO3	3	2	2	1	1				1		2	1
CO4	3	3	2	1	2		1		1		2	1
CO5	3	1	1		1		1				2	1
CO6	1	1	1						1		1	1

Course Contents:

Unit 1: Introduction

Finite element analysis and its need, Advantages and limitations of finite element analysis (FEA), FEA procedure.

Unit 2: Elements of Elasticity

Stress at a point, Stress equation of equilibrium, 2-D state of stress, Strains and displacements, Stress-strain relationship for 2-D state of stress, Plane stress and plane strain approach.

Unit 3: Relevant Matrix Algebra

Addition, subtraction and multiplication of matrices, Differentiation and integration of matrices, Inverse of a matrix, Eigen values and eigen vectors, Positive definite matrix, Gauss elimination.

Unit 4: One-Dimensional Problems

Introduction, FE modeling, Bar element, Shape functions, Potential energy approach, Global stiffness matrix, Boundary conditions and their treatments, Examples.

Unit 5: Trusses and Frames and Two-dimensional Problems

Introduction, Plane trusses, Element stiffness matrix, Stress calculations, Plane frames, examples.

Two-dimensional Problems

Introduction and scope of 2-D FEA, FE modeling of 2-D problem, Constant strain triangle, other finite elements (no mathematical treatment included), Boundary conditions.

Texts:

T. R. Chandrupatla, A.D. Belegundu, "Introduction to Finite Elements in Engineering", Prentice Hall of India Pvt. Ltd., 3rd edition, New Delhi, 2004.

P. Seshu, "A Textbook of Finite Element Analysis", Prentice Hall of India Pvt. Ltd., New Delhi, 2003.

R. D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt, "Concepts and Applications of Finite Element Analysis", John Wiley &Sons, Inc.

References:

K. J. Bathe, "Finite Element Procedures", Prentice Hall of India Pvt. Ltd., 2006.

Computational Fluid Dynamics

BTAPE604B	Computational Fluid Dynamics	PEC 4	3L-0T-0P	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to

CO1	Identify applications of finite volume and finite element methods to solve Navier-Stokes equations.
CO2	Evaluate solution of aerodynamic flows. Appraise & compare current CFD software. Simplify flow problems and solve them exactly.
CO3	Design and setup flow problem properly within CFD context, performing solid modeling using CAD package and producing grids via meshing tool
CO4	Interpret both flow physics and mathematical properties of governing Navier-Stokes equations and define proper boundary conditions for solution.
CO5	Use CFD software to model relevant engineering flow problems. Analyse the CFD results Compare with available data, and discuss the findings

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents:

Unit-I: Introduction to CFD
CFD – a research and design tool, CFD as third dimension of engineering supplementing theory and experiment, Steps in CFD solution procedure, strengths and weakness of CFD, Flow modelling using control volume - finite and infinitesimal control volumes, Concept of substantial derivative, divergence of velocity, Basic governing equations in integral and differential forms – conservation of mass, momentum and energy (No derivations), Physical interpretation of governing equations, Navier-Stoke's model and Euler's model of equations.

Unit- II: Basic Discretization Techniques
Introduction to grid generation (Types of grids such as structured, unstructured, hybrid, multiblock, Cartesian, body fitted and polyhedral etc.), Need to discretize the domain and governing equations, Finite difference approximation using Taylor series, for first order (Forward Difference Approximation, Backward Difference Approximation, Central difference Approximation) and second order (based on 3 node, 4 node and 5 node points),explicit and Implicit approaches applied to 1D transient conduction equation, Couetteflow equation () using FTCS and Crank Nicholson's Method, Stability Criteria concept and physical interpretation, Thomas Tri-diagonal matrix solver.

Unit-III: Two Dimensional Steady and unsteady heat conduction
Solution of two dimensional steady and unsteady heat conduction equation with Dirichlet, Neumann, Robbins and mixed boundary condition – solution by Explicit and Alternating Direction Implicit method (ADI Method), Approach for irregular boundary for 2D heat conduction problems.

Unit-IV: Application of Numerical Methods to Convection – Diffusion system
Convection: first order wave equation solution with upwind, Lax–Wendroff, Mac Cormack scheme, Stability Criteria concept and physical interpretation **Convection –Diffusion:** 1D and 2D steady Convection Diffusion system – Central difference approach, Peclet Number, stability criteria, upwind difference approach, 1 D transient convection-diffusion system

Unit-V: Incompressible fluid flow
Solution of Navier-Stoke's equation for incompressible flow using SIMPLE algorithms and its variation (SIMPLER), Application to flow through pipe, Introduction to finite volume method.
CFD as Practical approach

Introduction to any CFD tool, steps in pre-processing, geometry creation, mesh generation, selection of physics and material properties, specifying boundary condition, Physical Boundary condition types such as no slip, free slip, rotating wall, symmetry and periodic, wall roughness, initialising and solution control for the solver, Residuals, analysing the plots of various parameters (Scalar and Vector contours such as streamlines, velocity vector plots and animation). Introduction to turbulence models.Reynolds Averaged Navier-Stokes equations (RANS), k-ϵ, k-. Simple problems like flow inside a 2-D square lid driven cavity flow through the nozzle

Texts/References:

1. "Computational Fluid Dynamics", John D Anderson: The Basics with Applications, McGraw-Hill
2. "Computational Fluid Dynamics", J. Tu, G.-H. Yeoh and C. Liu: A practical approach, Elsevier.
3. "Introduction to Computational Fluid Dynamics", A. W. Date: Cambridge University Press
4. "Computer Simulation of Fluid flow and heat transfer", P.S.Ghoshdastidar: Tata McGraw-Hill.
5. "Numerical Simulation of internal and external flows", Vol. 1, C. Hirsch, Wiley
6. Computational Fluid Mechanics and Heat transfer, Tannehill, Anderson, and Pletcher,

Open Elective-II

Quantitative Techniques in Project Management

BTMOE605A	OEC 2	Quantitative Techniques in Project Management	3-1-0	4Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Engineering Mathematics-I/II/III

Course Outcomes: At the end of the course, students will be able to:

CO1	Define and formulate research models to solve real life problems for allocating limited resources by linear programming.
CO2	Apply transportation and assignment models to real life situations.
CO3	Apply queuing theory for performance evaluation of engineering and management systems.
CO4	Apply the mathematical tool for decision making regarding replacement of items in real life.
CO5	Determine the EOQ, ROP and safety stock for different inventory models.
CO6	Construct a project network and apply CPM and PERT method.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	3	2				3	1	3	1
CO2	3	1	1	3	2				3	2	3	1
CO3	3	1	1	3	2				3	2	3	1
CO4	3	1	1	3	2	1			3	2	3	1
CO5	3	1	1	3	2	1			3	2	3	1
CO6	3	1	1	3	2	2			3	2	3	1

Course Contents:

Unit 1: Introduction

Introduction to Operations Research, Stages of Development of Operations Research, Applications of Operations Research, Limitations of Operations Research Linear programming problem, Formulation, graphical method, Simplex method, artificial variable techniques.

Unit 2: Assignment and Transportation Models

Transportation Problem, North west corner method, Least cost method, VAM, Optimality check methods, Stepping stone, MODI method, Assignment Problem, Unbalanced assignment problems, Travelling salesman problem.

Unit 3: Waiting Line Models and Replacement Analysis

Queuing Theory: Classification of queuing models, Model I (Birth and Death model) M/M/I (∞, FCFS), Model II - M/M/I (N/FCFS).

Replacement Theory, Economic Life of an Asset, Replacement of item that deteriorate with time, Replacement of items that failed suddenly.

Unit 4: Inventory Models

Inventory Control, Introduction to Inventory Management, Basic Deterministic Models, Purchase Models and Manufacturing Models without Shortages and with Shortages, Reorder level and optimum buffer stock, EOQ problems with price breaks.

Unit 5: Project Management Techniques and Time and Cost Analysis

Difference between project and other manufacturing systems. Defining scope of a project, Necessity of different planning techniques for project managements, Use of Networks for planning of a project, CPM and PERT.

Time and Cost Analysis

Time and Cost Estimates: Crashing the project duration and its relationship with cost of project, probabilistic treatment of project completion, Resource allocation and Resource leveling.

Texts:

1. P. K. Gupta, D. S. Hira, “Operations Research”, S. Chand and Company Ltd., New Delhi, 1996.

2. L. C. Jhamb, "Quantitative Techniques for managerial Decisions", Vol. I and II, Everest Publishing House, Pune, 1994.
3. N. D. Vohra, "Operations Research", Tata McGraw Hill Co., New Delhi.

References:

1. H. Taha, "Operations Research–An Introduction", Maxwell Macmillan, New York.
2. J. K. Sharma, "Operations Research–An Introduction", Maxwell Macmillan, New Delhi.
3. Harvey M. Wagner, "Principles of Operations Research with Applications to Managerial Decisions", Prentice Hall of India Pvt. Ltd., New Delhi, 2nd edition, 2005.
4. Rubin and Lewin, "Quantitative Techniques for Managers", Prentice Hall of India Pvt. Ltd., New Delhi.

Nanotechnology

BTMOE605B	OEC2	Nanotechnology	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Demonstrate the understanding of length scales concepts, nanostructures and nanotechnology.
CO2	To impart basic knowledge on various synthesis and characterization techniques involved in Nanotechnology
CO3	To educate students about the interactions at molecular scale
CO4	Evaluate and analyze the mechanical properties of bulk nanostructured metals and alloys, Nano-composites and carbon nanotubes.
CO5	To make the students understand about the effects of using nanoparticles over conventional methods

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1		3	3	2	1		3		1	3
CO2	3	2			3	3	2				1	3

CO3	1	1	1	3	2				2	1		1
CO4	1	1		3	3	2	1		3		1	3
CO5	1	1	1	3	2				2	1		1

Course Contents:

Unit 1: Scientific Revolutions
Types of Nanotechnology and Nano machines: the Hybrid nanomaterial. Multiscale hierarchical structures built out of Nano sized building blocks (nano to macro).Nanomaterial's in Nature: Nacre, Gecko, Teeth. Periodic table, Atomic Structure, Molecules and phases, Energy, Molecular and atomic size, Surfaces and dimensional space: top down and bottom up.

Unit 2: Forces between Atoms and Molecules
Particles and grain boundaries, strong Intermolecular forces, Electrostatic and Vander Waals forces between surfaces, similarities and differences between intermolecular and inter particle forces covalent and coulomb interactions, interaction polar molecules.
Thermodynamics of self-assembly.

Unit 3: Opportunity at the Nano Scale
Length and time scale in structures, energy landscapes, Inter dynamic aspects of inter molecular forces, Evolution of band structure and Fermi surface.

Unit 4: Nano Shapes
Quantum dots, Nano wires, Nano tubes, 2D and 3D films, Nano and mesopores, micelles, bilayer, vesicles, bionano machines, biological membranes.

Unit 5: Influence of Nano Structuring and Nano Behaviour
Influence of Nano structuring on mechanical, optical, electronic, magnetic and chemical properties-gram size effects on strength of metals- optical properties of quantum dots.
Nano Behaviour
Quantum wires, electronic transport in quantum wires and carbon nano-tubes, magnetic behavior of single domain particles and nanostructures, surface chemistry of Tailored monolayer, self-assembling.
Texts:
1. C. Koch, "Nanostructured materials: Processing, Properties and Potential Applications", Noyes Publications, 2002.

2. C. Koch, I. A. Ovidko, S. Seal and S. Veprek, "Structural Nano crystalline Materials: Fundamentals & Applications", Cambridge University Press, 2011.

References:
1. Bharat Bhushan, "Springer Handbook of Nanotechnology", Springer, 2nd edition, 2006.

2. Laurier L. Schramm, "Nano and Microtechnology from A-Z: From Nano-systems to Colloids and Interfaces", Wiley, 2014.

Energy Conservation and Management

BTMOE605C	OEC2	Energy Conservation and Management	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Understand energy problem and need of energy management
CO2	Carry out energy audit of simple units
CO3	Study various financial appraisal methods
CO4	Analyse cogeneration and waste heat recovery systems
CO5	Do simple calculations regarding thermal insulation and electrical energy conservation

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	1	2	3		2	3			2	2		2
CO2	1	1	3	1	2	3			2	2		2
CO3	2	1	1							1		2
CO4	3	3			2	3						1
CO5			3			2						1

Course Contents:

Unit1: Introduction

General energy problem, Energy use patterns and scope of conservation. Energy Management Principles: Need, Organizing, Initiating and managing an energy management program.

Unit2: Energy Auditing

Elements and concepts, Types of energy audits, Instruments used in energy auditing.

Economic Analysis: Cash flows, Time value of money, Formulae relating present and future cash flows-single amount, uniform series.

Unit3: Financial Appraisal Methods

Paybackperiod, Netpresentvalue, Benefit-costratio, Internal-rate of return, Life cycle costs/benefits. Thermodynamics of energy conservation, Energy conservation in Boilers and furnaces, Energy conservation in Steam and condensate system.

Unit4: Cogeneration and Insulation and Heating

Concept, Types of cogeneration systems, performance evaluation of a cogeneration system.

Waste Heat Recovery: Potential, benefits, waste heat recovery equipment's.

Space Heating, Ventilation Air Conditioning (HVAC) and water heating of building, Transfer of heat, Space heating methods, Ventilation and air conditioning, Heat pumps, Insulation, Cooling load, Electric water heating systems, Electric energy conservation methods.

Insulation and Heating

Industrial Insulation: Insulation materials, Insulation selection, Economical thickness of insulation. Industrial Heating: Heating by indirect resistance, direct resistance heating (salt bath furnace), and Heat treatment by induction heating in the electric arc furnace industry.

Unit5: Energy Conservation in Electric Utility and Industry

Energy costs and two part tariff, Energy conservation in utility by improving load factor, Load curve analysis, Energy efficient motors, Energy conservation in illumination systems, Importance of Power factor in energy conservation, Power factor improvement methods, Energy conservation in industries

Texts:

1. Callaghan,"EnergyConservation".
2. D.L.Reeg,"IndustrialEnergyConservation",PergamonPress.

References:

1. T.L.Boyen,"ThermalEnergyRecovery",WileyEastern.
2. L.J.Nagrath,"SystemModelingandAnalysis",TataMcGrawHill Publications.
3. S.P.Sukhatme,"SolarEnergy",TataMcGrawHill Publications.

Wind Energy

BTMOE605D	OEC2	Wind Energy	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Understand historical applications of wind energy
CO2	Understand and explain wind measurements and wind data
CO3	Determine Wind Turbine Power, Energy and Torque
CO4	Understand and explain Wind Turbine Connected to the Electrical Network AC and DC
CO5	Understand economics of wind energy

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							2	2	2	1		1

CO2		3	2	1	3	2	2	2	2			1
CO3	3	3	1	1	2	2	1					1
CO4	3	3		1								1
CO5	3	2	1									1

Course Contents:

Unit 1: Introduction and Wind Measurements
Historical uses of wind, History of wind electric generations

Wind Characteristics: Metrology of wind, World distribution of wind, Atmospheric stability, Wind speed variation with height, Wind speed statistics, Weibull statistics, Weibull parameters, Rayleigh and normal distribution
Wind Measurements
Biological indicators, Rotational anemometers, other anemometers, Wind direction

Unit 2: Wind Turbine Power, Energy and Torque
Power output from an ideal turbine, Aerodynamics, Power output from practical turbines, Transmission and generation efficiency, Energy production and capacity factor, Torque at constant speeds, Drive train oscillations, Turbine shaft power and torque at variable speeds.

Unit 3: Wind Turbine Connected to the Electrical Network
Methods of generating synchronous power, AC circuits, the synchronous generator, per unit calculations, the induction machine, motor starting, Capacity credit features of electrical network

Unit 4: Wind Turbines with Asynchronous Electric Generators
Asynchronous systems, DC shunt generator with battery load, Per unit calculation, Self-excitation of the induction generators, Single phase operation the induction generator, Field modulated generators, Roesel generator.
Asynchronous Load: Piston water pumps, Centrifugal pumps, Paddle wheel heaters, Batteries, Hydrogen economy, and Electrolysis cells.

Unit 5: Economics of Wind Systems
Capital costs, Economic concepts, Revenues requirements, Value of wind generated electricity

Texts:
1. S. Ahmad, “Wind Energy: Theory and Practice”, Prentice Hall of India Pvt. Ltd.

References:
1. Garg L. Johnson, “Wind Energy Systems” Prentice Hall Inc., New Jersey, 1985.

2. Desire Le Gouriers, “Wind Power Plants: Theory and Design” Pergamon Press, 1982.

Introduction to Probability Theory and Statistics

BTMOE605D	Introduction to Probability Theory and Statistics	OEC 2	3L-1T-0P	4 Credits

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week Tutorial:1 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Objective

The objective of this course is

(i)To Acquire the knowledge of mean, median, mode, dispersion, etc.
(ii) To develop the basics of Probability theory
(iii) To get the knowledge of random variables and their expectations
(iv) To establish acquaintance with various probability distributions
(v) To Acquire the knowledge of correlation and regression.

Course Outcome

At the end of the course, the student will be able to

(i) Apply the concepts tofind the measure of the central tendency, dispersion and moments for grouped data

(ii) Make use of the correlation, and regression analyses to find the correlation and regression coefficients

(iii) Observe and analyze the behavior of various discreteand continuous probability distributions

(iv) Investigate the properties such as mathematical expectation and variance of the random variables.

Course Contents:

Unit I: Probability

Probability Theory: Definition of probability, Addition theorem of probability, Multiplication theorem of probability, Conditional probability, Bayes' theorem of inverse probability, Properties of probabilities with proofs. **[08 Hours]**

Unit II: Theoretical Probability Distributions

Theoretical Probability Distributions: Binomial distribution, Poisson distribution, Normal distribution, Fitting of binomial distributions, Properties of Binomial, Poisson and normal distributions, Relation between binomial and normal distributions, Relation between Poisson and normal distributions, Importance of normal distribution, Examples. **[08 Hours]**

Unit III: Moments, Skewness and Kurtosis

Moments about mean and an arbitrary point; Skewness: positive skewness, negative skewness, symmetric frequency distribution, Bowley's coefficient of skewness, Karl Pearson's coefficient of skewness,

Measures of skewness based on moments (β_1, γ_1); Concepts of kurtosis, leptokurtic, mesokurtic and platykurtic frequency distributions. **[08 Hours]**

Unit IV: Correlation and Regression

Correlation: Types of correlation, Karl Pearson's correlation coefficient (Covariance Method), Spearman's rank correlation method, Regression: lines of regression, fitting of lines of regression by the least squares method, interpretation of slope and intercept, properties of regression coefficients. **[08 Hours]**

Unit V: Sampling Theory and Testing of Hypothesis

Introduction to sampling distributions, Population and sample, Null hypothesis and Alternative hypothesis, Single and two tailed test, Testing of hypothesis, Level of significance, Critical region, Procedure for testing of hypothesis. **[08 Hours]**

Text Books:

1. Fundamentals of Statistics by S. C. Gupta, Himalaya Publishing House Pvt. Ltd., New Delhi.
2. Probability and Statistics by Dr. B. B. Singh, Synergy Knowledgeware, Mumbai.
3. Mathematical Statistics by P. Mukhopadhyay, New Central Book Agency, Kolkata.
4. Fundamentals of Mathematical Statistics by S. C. Gupta and V. K. Kapoor, S. Chand and Sons, New Delhi.

5. An Introduction to Probability and Statistics by V. K. Rohatgi and A. K. Md. EhsanesSaleh,WileyInterscience Publication, New York.
6. Introduction to Probability and Statistical Applications by P. L. Meyer, Addison Wesley Publishing Co., Massachusetts.

Reference Books:

1. Probability, Statistics with Reliability, Queuing and Computer Science Applications by Kishor S. Trivedi, Wiley India Pvt. Ltd., Mumbai.
2. Probability, Queuing Theory and Reliability Engineering by G. Haribaskaran, Laxmi Publications, New Delhi.
3. Probability and Statistics by R. S. Murray, J. S. John, R. Alu Srinivasan and D. Goswami, Schaum's Outlines series, McGraw Hill Publications, New Delhi.
4. Introduction to Theory of Statistics by A. M. Mood, F. A. Graybill and D. C. Boes, Tata McGraw – Hill Publications, Pune.

Production Engineering Lab-IV

PCC14	BTPCL606	**Production Engineering Lab IV**	0-0-4	Credit

Practical Scheme:	**Examination Scheme:**
Practical: 4hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

ListofPractical's/Experiments/Assignments (Any 4 from Group-A, Any 4 from Group-B and Any 3 from Group-C):

Group-A (CAD/CAM/CIM):

1. PartmodelingofmachineelementsusinganyoneoftheCADsoftwareoutofProE,CATIA,UnigraphicsorAutodeskInventorProfessional.

2. Assemblymodelingofassemblyorsub-assemblyofengineeringproductsusinganyoneoftheCADsoftwareoutofProE,CATIA,UnigraphicsorAutodeskInventorProfessional.
3. DraftingofPartsandAssemblyofengineeringassemblyusinganyoneoftheCADsoftwareoutofProE, CATIA, Unigraphics, orAutodeskInventorProfessional.
4. Minimum4structuralanalysisproblemstobesolvedusingaCAEsoftwarelike Ansys,Hyperworksetc.
5. Minimum2Jobs(Programs)onCNCTurningoperations
6. Minimum2Jobs(programs)onCNCMillingoperation
7. CaseStudyofanIndustrialRobot

Group-B (CNC Machines and Programming Lab):

ListofPractical's/Experiments/Assignments

Each student shall be required to complete and submit the manual for the list of experiments. Each experiment will last for 2 turns.

1. To develop a manual part program of a given component on CNC Lathe using G and M codes.
2. To develop a manual part program of a given component on CNC Lathe using stock removal cycle.
3. To develop a manual part program of a given component on CNC Lathe using canned cycle.
4. To develop a manual part program of a given component on CNC Milling machine using G and M code.
5. To develop a manual part program of a given component on CNC Milling machine using pocket milling cycles.
6. To develop a manual part program of a given component on CNC Milling machine using canned drilling cycle.

Group-C (Metrology and Quality Control):

ListofPractical's/Experiments/Assignments

1. Calibration of pressure gauge using dead weight gauge calibrator
2. Measurement of displacement using LVDT
3. Calibration of strain gauge
4. Measurement of flow rate using orifice, venture and Rota meters and their error analysis
5. Measurement of flow rate using microprocessor based magnetic flow meter, vortex, Ultrasonic, turbine flow meters
6. Determination of characteristics of thermocouples, RTD, thermistors
7. To calibrate the given micrometer using slip gauge as standard
8. Measurement of taper by sine bar
9. To calibrate a dial gauge indicator

10. Study and use of optical flat
11. Surface roughness measurement
12. Tool makers' microscope.

B. Tech Seminar

BTPS607	B Tech Seminar	PROJ-3	0L-0T-2P	1 Credits

Teaching Scheme:	**Examination Scheme:**
Practical: 2 hrs/week	Continuous Assessment: 60 Marks Mid Semester Exam: -- End Semester Exam: 40 Marks

Objective:

- To expose and make students aware with latest research and research publications
- To understand the research and research publication, references, citation
- To enhance the presentation skill
- To enhance the report writing
- To make the student aware about research publication sites

Students are expected to prepare a seminar report on the chosen topic/area selected with the discussion of chosen guide based on the available literature on the chosen topic.

Mini Project

BTPP608	Mini Project	PROJ-4	0L-0T-2P	1 Credits

Teaching Scheme:	**Examination Scheme:**
Practical: 2 hrs/week	Continuous Assessment: 60 Marks

	Mid Semester Exam: -- End Semester Exam: 40 Marks(Duration 03 hrs)

Students are expected to carry out a mini project under a project guide based on the chosen area. The project may be prototype/software based which may demonstrate Engineering application or community service. After completion the project work it is necessary that student should prepare a project report under the supervision of the assign guide and present before the committee.

Semester-VII

Mechatronics

BTMC701	PCC15	Mechatronics	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Define sensor, transducer and understand the applications of different sensors and transducers
CO2	Explain the signal conditioning and data representation techniques
CO3	Design pneumatic and hydraulic circuits for a given application
CO4	Write a PLC program using Ladder logic for a given application
CO5	Understand applications of microprocessor and micro controller
CO6	Analyse PI, PD and PID controllers for a given application

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	3	2				2	1		1
CO2	3	2			3	3	2				1	3
CO3	1	1		3	3	2	1		3		1	3
CO4	3	3	1	1	3		1	1	1			
CO5	3			1	3	2	3					2
CO6		3	3		3	3	1	1	3			2

Course Contents:

Unit 1: Introduction

Introduction to Mechatronic systems, elements, advantages; practical examples of Mechatronic systems.

Sensors and Transducers: Various types of sensors and transducers used in Mechatronic system such as pressure sensors, temperature sensors, velocity sensors, Acceleration sensors, proximity sensors, position sensors, force sensors, Optical encoders, Capacitive level sensor, tactile sensors, Selection of sensors.

Unit 2: Signal Conditioning and Data Representation

Types of electronic signals, Need for signal processing, Operational amplifiers: Types, classification and applications, Opto-isolators, Protection devices, Analogue to Digital and Digital to Analog Converters, Interfacing devices, Electro-magnetic Relays.

Data representation systems, Displays, Seven segment displays, LCD displays, Printers, Data loggers, Data Acquisition Cards/Systems

Unit 3: Drives

Electrical Drives: Types of Electrical Motors, AC and DC motors, DC servomotors, Stepper motors, linear motors, etc.

Pneumatics and Hydraulics: Components of Pneumatic systems, actuators, direction control valves, pneumatic air preparation, FRL unit, methods of actuation of valves, Sequencing of Pneumatic cylinders using Cascade and shift register methods. Electro-pneumatic valves, Electro- pneumatic circuits using single and double solenoid methods.

Hydraulic cylinders, design of cylinder, Design of Piston and piston rod, Valves, poppet valve, house pipes and design of tubing, Meter-in and Meter-out circuits.

Unit 4: Microprocessor and Microcontroller

8085 microprocessor: architecture, various types of registers and their functions in 8085µP, Instruction sets, interfacing, applications. 8081 microcontroller: architecture, Instruction sets, various pins and their functions interfacing, applications.

Programmable Logic Controller: Introduction, Architecture, Types of inputs/outputs, Specifications, guidelines for Selection of PLCs, Programming: Ladder logic and FBD

Unit 5: Control Systems and its Stabilty

Open and closed loop system; block diagram manipulation/reduction, Transfer function, modeling of Mechanical Systems using Spring, Dashpot and Mass equivalence.

Stability of Systems

On/Off controller, Proportional Control, Integral control, Derivative Control; PI, PD and PID Controllers, Introduction to control using state variable system models, Bode Plots and stability criteria.

Texts:

1. HMT Limited, "Mechatronics", Tata McGraw Hill Publications, 1998.
2. W. Bolton, "Mechatronics; Electronic Control System in Mechanical Engineering", Pearson Education Asia, 1999.
3. Raven, "Automatic Control Engineering", Tata McGraw Hill Publications, New York, 1986.

References:

1. R. K. Rajput, "A textbook of Mechatronics", S. Chand and Co., 2007.
2. Michael B. Histand, David G. Alciatore, "Introduction to Mechatronics and Measurement Systems", Tata McGraw Hill International Editions, 2000.
3. D. A. Bradley, D. Dawson, N. C. Buru, A. J. Loader, "Mechatronics", Chapman and Hall, 1993

Industrial Engineering and Management

BTHM702	HSSMC4	Industrial Engineering and Management	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Impart fundamental knowledge and skill sets required in the Industrial Management and Engineering profession, which include the ability to apply basic knowledge of mathematics, probability and statistics, and the domain knowledge of Industrial Management and Engineering
CO2	Produce ability to adopt a system approach to design, develop, implement and innovate integrated systems that include people, materials, information, equipment and energy.
CO3	Understand the interactions between engineering, businesses, technological and environmental spheres in the modern society.
CO4	Understand their role as engineers and their impact to society at the national and global context.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1											2	1
CO2									2	2	2	
CO3								2				
CO4								2				2

Course Contents:

Unit 1: Introduction
Managing and managers, management- science, theory and practice, functions of management, evolution of management theory, contributions of Taylor, Fayol and others.
Planning: The nature and purpose of planning, objectives, strategies, policies and planning premises, decision making.
Organizing: The nature and purpose of organizing, departmentation, Line/ staff authority and decentralization, effective organizing and organizational culture.

Unit 2: Human Resource Management
Staffing: Human resource management and selection, orientation, apprentice training and Apprentice Act (1961), performance appraisal and career strategy, job evolution and merit rating, incentive schemes.
Leading: Managing and human factor, motivation, leadership, morale, team building, and communication.
Controlling: The system and process of controlling control techniques, overall and preventive control.

Unit 3: Production/Operations Management
Operations management in corporate profitability and competitiveness, types and characteristics of manufacturing systems, types and characteristics of services systems.
Operations planning and Control: Forecasting for operations, materials requirement planning, operations scheduling.

Unit 4: Design of Operational Systems
Product/process design and technological choice, capacity planning, plant location, facilities layout, assembly line balancing, and perspectives on operations systems of the future.

Unit 5: Introduction to Industrial Engineering and Ergonomics
Scope and functions, history, contributions of Taylor, Gibreth, Gantt and others.
Work Study and Method Study: Charting techniques, workplace design, motion economy principles.
Work Measurement: Stopwatch time study, micro motion study, predetermined time system (PTS), work sampling.
Ergonomics
Basic principles of ergonomics

Concurrent Engineering: Producibility, manufacturability, productivity improvement.
Total Quality Management: Just in time (JIT), total quality control, quality circles, six sigma.

Texts:

1. H. Koontz, H. Weirich, "Essentials of Management", Tata McGraw Hill book Co., Singapore, International Edition, 5th edition, 1990.
2. E. S. Buffa, R. K. Sarin, "Modern Production/Operations Management", John Wiley and Sons, New York, International Edition, 8th edition, 1987.
3. P. E. Hicks, "Industrial Engineering and Management: A New Perspective", Tata McGraw Hill Book Co., Singapore, International Edition, 2nd edition, 1994.

References:

1. J. L. Riggs, "Production Systems: Planning, Analysis and Control", John Wiley & Sons, New York, International Edition, 4th edition, 1987.
2. H. T. Amrine, J. A. Ritchey, C. L. Moodie, J. F. Kmec, "Manufacturing Organization and Management", Pearson Education, 6th edition, 2004.

International Labour Organization (ILO), "Introduction to Work Study", International Labour Office, Geneva, 3rd edition, 1987.

Elective-V

Tool Design

BTPPE703A	PEC5	Tool Design	3-0-0	3Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Objectives: To understand tool configuration, it's functioning and wear characteristics, Tool materials and developments, application. To understand orthogonal cutting process and forces involved in the cutting. To evolve design of jigs and fixtures for the effective use of machining processes.
Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Identify ASA and ORS systems of tool geometry.
CO2	Classify the geometry of single point and multi point cutting tool
CO3	Apply principles of locating and clamping systems, and Design jig and fixture for conventional and NC machining
CO4	Select and design progressive, compound or combination dies for press working operations
CO5	Select and design drawing, and bending dies.
CO6	Categorize forging operations with single and multi-impression dies

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		1			1							1
CO2		1										1
CO3	2	2	2		1							
CO4	1	2	1	1	2		1					2
CO5		2	1		2							2
CO6	1	2	1		1				1			1

Course Contents:

Unit 1: Design of Single Point Cutting Tools
Introduction, designation of cutting tools, ORS and ASA system, Importance of tool angles, design of chip breakers , machining forces and merchant's circle diagram. Taylor's tool life equation.

Unit 2: Design of Multipoint Cutting Tools
Drill: Nomenclature, design of drill, moment, thrust force and power required. Milling Cutters: Nomenclature, design of milling cutter, power required for milling. Broaches: Nomenclature, design of broach, broaching power, length of toothed portion.

Unit 3: Design of Jigs and Fixtures
Twelve degree of freedom, 3-2-1, 4-2-1 method of location, Redundancy, fool proofing, locating & clamping**:** locating devices, clamping devices, Quick acting devices, drill bushes, Drilling jigs**:** need, design principles, types of drilling jigs. Milling fixtures**:** essential features of a milling fixtures, types, Indexing of Jigs and Fixtures.

Unit 4: Press Tool Design
Press working equipment, press selection, types of dies, clearance, angular clearance, stripper plate, cutting forces , method of reducing cutting forces , die block design, punch , punch design , methods of holding punch, centre of pressure, scrap strip layout. Blanking die design, piercing die design, design of progressive dies.

Unit 5: Bending and Drawing Dies

Bending Dies: v-bending, bending forces, bend allowance, spring back and its prevention, design principles.

Drawing Dies: introduction , difference between bending , and drawing , metal flow during drawing, design consideration: radius of draw die, punch radius, draw clearance, drawing speed, calculation of blank size, number of draws, drawing pressure, blank hold pressure.

Forging Die Design and Mould Design

Forging dies, single impression dies, multiple impression dies,

Forging design factors: draft, fillet and corner radius, parting line, shrinkage and die wear, mismatch, finish allowances, webs and ribs.

Die design for drop forging and press forging: preliminary forging operation, fullering, edging, bending, flattering, blocking, finishing, cutoff, die block dimensions. Determination of stock size in closed and open die forging

Mould design: injection mould, mould base, design of simple two plate injection moulds, mould materials.

Texts:

1. P.C.Sharma, “A Text Book of Production Engineering”, S. Chand & company ltd., New Delhi, 2001.
2. P.H.Joshi, “Jigs & Fixtures”, Tata McGraw Hill Publishing Co. New Delhi,2001.
3. M.H.A. Kempster, “Introduction of Jigs and Fixtures design”, The English Language Book Society and Hodder and Stoughton, London, 3rd edition, 1982.

References:

1. GeofferyBoothroyd, Winston Knight, “Fundamentals of Machining and Machine Tools”, Taylors and Francis, 3rd edition, 2006.
2. E. G. Hoffman, “Jigs and Fixtures”, 5th Cengage Learning, 2004.

Reliability and Terotechnology

BTPPE703B	PEC5	Reliability and Terotechnology	3-0-0	3Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Objectives: To study importance of reliability function and terotechnology.

Pre-Requisites: Machine design and Manufacturing processes-II

Course Outcomes: At the end of the course, students will be able to:

CO1	Define the reliability and derive it's function
CO2	Classify the methods of improving and determining the reliability
CO3	Illustrate the maintainability and availability concept
CO4	Estimate the life cycle cost of different models and apply failure analysis methods
CO5	Select particular maintenance strategy for the breakdown and influence of terotechnology
CO6	Identify various condition monitoring techniques and their application

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1		1									
CO2	1	1	1									
CO3	1		1	1								
CO4	1	1	1	1								
CO5	1		1	1								
CO6	1		1				1					

Course Contents:

Unit 1: Reliability

Definition -methods of improving reliability, derivation of Reliability function, configurations of reliability, series parallel & mixed configuration, simple problems

Unit 2: Reliability Calculations

Methods of improving reliability, redundancy element, unit stand-by redundancy, reliability models, constant hazard, simple problems, hazard models.

Unit 3: Maintenance Systems

Objective, of maintenance, maintainability and availability concepts, types of availability -mean time to failure-mean time between failures-mean time to repair-mean down time-Reliability allocation

Unit 4: Life Cycle Costing and Failure Analysis

Techno economic Life; Reliability effort function, simple cost models for Life cycle.

Unit 5: Maintenance Management

Principles types of maintenance breakdown, periodic, preventive and total productive maintenance, maintenance planning and control strategies, maintenance planning, maintenance policies, maintenance organization, maintenance standards-quality service standards-maintenance Strategy, influence of Terotechnology on maintenance management-maintenance performance indices, maintenance system documentation. Failure Analysis: using causes & effects using Ishikawa diagram FMEA, FMECA.

Condition Monitoring

Definitions, advantages, limitations, through ferrography and particle analyzer, spectroscopic oil analysis program (SOAP), contaminant analysis, vibration monitoring, use of monitoring, instruments and applications-magnetic chip detector. Role of computers in condition monitoring.Monitoringsystems- layers & monitors.

Texts:

1. L. S. Srinath,"Reliability Engineering",Affiliated East -West press, 2002.

References:

1. K. K. Ahuja, "Industrial management and Organizational Behaviour", Khanna Publications, 1999.
2. H. P. Garg, "Industrial Maintenance", S. Chand & company. Ltd, Third Edition 1990.
3. Dr. Shankar, "Industrial engineering Management" Golgotia Publications Pvt. Ltd. 1997.
4. S.K. Basu&B.Bhadury, "Terotechnology: Reliability Engineering& maintenance Management", Asian book Private Ltd., Delhi, 1st, Edition, 2003.
5. A.K. Gupta, "Reliability Engineering & Terotechnology".

Modeling of Manufacturing Systems

BTPPE703C	PEC5	Modeling of Manufacturing Systems	3-0-0	3Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Objectives: To study the performance modeling tools and able to develop a layout of assembly line by using various computer controlled machines.

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Compare various performance modeling tools.
CO2	Determine plant configurations and measure its performance.
CO3	Develop a layout of assembly line by using various computer controlled machines.
CO4	Illustrate flexible manufacturing systems.
CO5	Compare various line models.
CO6	Apply queuing theory to manufacturing systems.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1		1	1							
CO2	1	1		1	1							
CO3	1	1			1							
CO4	1	1			1							1
CO5	1	1		1	1							
CO6	1	1				1						

Course Contents:

Unit 1: Modeling Automated Manufacturing Systems
Role of performance modeling, Performance modeling tools – simulation models and analytical models

Unit 2: Automated Manufacturing Systems
Input-output model, Plant configurations, Performance measures.

Unit 3: Computer Controlled Machines
NC machines, Pallets and fixtures, Machining centers, Automated inspection systems, Material handling systems – conveyors – industrial robots – automated guided vehicles – storage and retrieval systems, Facility layout – CRAFT – quadratic assignment problem, Group technology – coding schemes –production flow analysis – mathematical model

Unit 4: Flexible Manufacturing Systems
Architecture of FMS – automated workpiece flow – automated assembly systems – deadlocks – performance measures.

Unit 5: Line Models
Markov chain models, Geometric and exponential random variables, Stochastic processes – Poisson process, Discrete-time Markov chains, Continuous-time Markov chains, Markov model of a transfer line, Birth and death processes in manufacturing.

Queuing Theory
Basic queuing models – (M/M/1) – (M/M/m),Queues with breakdowns, Analysis of a flexible manufacturing center, Queuing networks – open – closed – product form, Queuing networks with blocking, Application of queuing models for manufacturing systems – simulation models for serials lines and flexible manufacturing.

Texts/References:

1. Viswanadham, N., and Narahari, Y, "Performance modeling of automated manufacturing systems" Prentice Hallof India, New Delhi, 1996.

2. Askin, R.G., and Standridge, C.R, "Modeling and Analysis of manufacturing systems" John Wiley& Sons, 1993.

3. Altiok, T, "Performance Analysis of Manufacturing Systems", Springer, 1997.

4. Brandimarte, P, "A Performance modeling of automated manufacturing systems" Prentice-Hall of India, New Delhi, 1996.

5. Curry, G.L., and Feldman, R.M, "Manufacturing systems modeling and analysis" Springer, 2011

Processing of Polymers

BTPPE703D	PEC5	Processing of Polymers	3-0-0	3Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Unit 1: Basic Concept: Plastic Additives and Compounding: Various additives and their purpose (e.g.
antioxidants, plasticizers, antistatic agents, blowing agents etc.), Principle of mixing and mixers, types.

Extrusion

Basic operation and analysis, solids conveying, drag induced conveying, melting mechanism, power consumption in metering zone. Overall extruder performance. Design of extrusion screws, modeling of extrusion process and computer simulation. Overall working of single screw and twin
screw extruders.

Unit 2 : Polymer Devolatilization

Basic analysis of the process, functional design considerations, screw geometry and design Devolatilization in single screw and twin screw extruders and their design.

Extruded products

Such as films, pipes, profiles, coating, foamed products, design of sizing systems, haul off Systems, cooling and / or chilling units, winders, auxiliary equipment's used, measurement and Control of parameters. Types of dies used for the production of extruded products. Analysis of

the
flow through the dies. Manufacture of flat films, co extruded films, oriented films, drawing and stretching units.

Unit 3: Reactive extrusion and resident time distribution (RTD)
Process details, basic principles, equipment used, effective residence time and residence time distribution (RTD), point measurements: characterization of melting and mixing time with the RTD, applications.
Extrusion blow molding
Types of blow molding techniques, flow analysis in the die, wall thickness control, parison swell, parison sag. Continuous and intermittent blow molding CAE of blow molding operation.

Unit 4: Thermoforming
Types, various techniques, materials, heat transfer analysis of the process, effect of plugs on article
thickness, continuous heating of a thin moving sheet. CAE in thermoforming.

Unit 5:Injection molding
Role of rheology in injection molding, melt flow in feed system, flow in mould cavity, mould filling. Control of politicizing and injection process.
Reaction injection molding
Overall molding cycle, metering system for components, mixing head design, mould construction,
materials used and their applications.
Other Processing techniques: Calendering and milling, compression and transfer molding, casting,
rotational molding, fabrication, decoration of polymers.
References:
1. Handbook of Plastics Test Method, R.B. Brown, George Godwin Limited, 1981.
2. Handbook of Plastic Testing Technology, Brown and Vishnu Shah, A. Wiley, Inter science Publication, 2007

3. Handbook of Plastics Test Methods, G.V. Eves, J.A. Mead, M.M. Riky.
4. Volume 8 of ASTM Standards, BIS Standards.
5. Polymer Extrusion, Chris Rauwendal SPE, Hanser Publishers.
6. Polymer Missing and Extrusion Technology – NicholasCheremisinoff, Marcel Dekker 1987
7. Modeling Of Polymer Processing, Isayav, Hanser Publishers, 1991.
8. Plastics Waste Management, Mustafa.
9. Plastics Extrusion Technology – Hanser SPE, 199 6
10. Thermoforming – J.L. Throne, Hanser Publishers 1987
11. Blow Molding Handbook – Rosato, Hanser Publish ers 1987
12. Mixing and Compounding of Polymers: Theory and Practice, Ica Manas-Zloczower, HanserVerlag, 2009.
13. Extrusion of Polymers: Theory and Practice, Chan I. Chung, HanserVerlag, 01-Apr-2000
14. Rotational Molding of Plastics – R. J. Crawfor d, Research Studies Press Ltd.

15. Engineering with Polymers - Powell.

Biomechanics

BTMPE703B	PEC 5	Biomechanics	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Explain various forces and mechanisms and define Newton's law of motion, work and energy, moment of inertia
CO2	Describe forces and stresses in different human joints
CO3	Discuss bio fluid mechanics in cardiovascular and respiratory system in human body
CO4	Differentiate between hard tissues and soft tissues
CO5	Understand concepts of implants and Identify different techniques used in biomechanics implants

Mapping of course outcomes with program outcomes

Course	Program Outcomes

Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1			1	1	1	1		1	1
CO2	2	2	2			1	2		1		1	1
CO3	2	2	2			1	1	1	1			1
CO4	1	1	1				1	1	1			1
CO5	1	1	2				1	1			1	1

Course Contents:

Unit 1: Introduction
Review of principle of mechanics, vector mechanics-resultant forces of coplanar and non-coplanar and concurrent and non-concurrent forces, parallel forces in planes, equilibrium of coplanar forces, Newton's law of motion, work and energy, moment of inertia.

Unit 2: Biomechanics of Joints
Skeletal joints, forces and stresses in human joints, type of joints, biomechanical analysis of elbow, shoulder, spinal column, hip knee and ankle.

Unit 3: Bio-fluid Mechanics
Introduction, viscosity and capillary viscometer, Rheological properties of blood, laminar flow, cardiovascular and respiratory system.

Unit 4: Hard Tissues
Bone structure and composition, Mechanical properties of bones, cortical and cancellous bones, visco-elastic properties, Maxwell and Vigot model – Anisotropy

Unit 5: Soft Tissues and Biomechanics of Implant
Structure and functions of soft tissue: cartilage, tendon, ligament and muscle, Material properties of cartilage, tendon and ligament and muscle

Biomechanics of Implant: Specification for prosthetic joints, biocompatibility, requirement of biomaterial, characterization of different type of biomaterials, fixation of implants.

Texts/References:

1. Y. C. Fung, "Biomechanics: Mechanical properties of living tissues", Springer-Verlag, 2nd edition, 1993.

D. J. Schneck, J. D. Bronzino, "Biomechanics: Principle and Applications", CRC Press, 2nd edition, 2000.

Non-conventional Machining

BTMPE703C	PEC5	Non-conventional Machining	3-0-0	3Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Manufacturing Processes

Course Outcomes: At the end of the course, students will be able to:

CO1	Classify Non-conventional machining processes.
CO2	Understand working principle and mechanism of material removal in various non-conventional machining processes.
CO3	Identify process parameters their effect and applications of different processes.
CO4	Summarized merits and demerits of non-conventional machining processes.
CO5	Explain the mechanism to design hybrid processes such as ELID grinding, EDCG, EDCM, etc.
CO6	Understand mechanism and working principle of micro machining using non-conventional processes.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	1				1		1
CO2	2	2	1		2	1	1			1		1
CO3	2	2	1	1	2	1	1			1		1
CO4	2	2	1		2	1	1			1		1
CO5	3	2	1	1	2	2	1			1		1
CO6	2	2	1	1	1	2	1			1		1

Course Contents:

Unit 1: Introduction to Non-Conventional Machining Processes
An overview, Trends in manufacturing, Classification of Non-Conventional Machining processes.

Unit 2: Chemical and Electrochemical Processes
Introduction, Types: CHM, ECM, Electrochemical grinding, electrochemical deburring, electrochemical honing, Mechanism of material removal, Process characteristics, Process parameters, Equipment and Tooling (maskantsand etchants), Advantages, applications and limitations.

Unit 3: Thermo-Electrical Processes
Electrical discharge machining, Electron beam machining, Ion beam machining, Plasma arc machining, Hot machining, Mechanism of material removal, Process characteristics, Process parameters, Equipment and Tooling, Advantages, applications and limitations.

Unit 4: Mechanical Processes
Ultrasonic machining, Abrasive jet machining, Abrasive flow machining, Water Jet cutting, Mechanism of material removal, Process characteristics, Process parameters, Equipment and Tooling, Advantages, applications and limitations.

Unit 5: Laser Based Machining Processes and Hybrid Processes
Types of lasers, Laser beam generation, Equipment and machining procedure, Process characteristics, Process parameters, Advantages and limitations of LBM, Applications.

Hybrid Processes
Concept, Mechanism of material removal, Process characteristics, Process parameters, Equipment and Tooling, classification, applications, advantages, Shaped tube electrolytic machining, Electrical discharge wire cutting, ELID grinding, Micro machining: Micro EDM, Micro ECM, Electro discharge chemical grinding (EDCG).

Texts:

1. P. C. Pande, H. S. Shan, “Modern Machining Process”, Tata McGraw-Hill Publications, New Delhi, 1980.
2. V. K. Jain, “Advanced Machining Processes”, Allied Publishers Pvt. Ltd., New Delhi, 2002.
3. P. K. Mishra, “Non-Conventional Machining”, Narosa Publishing House, New Delhi, 2007

References:

1. P. C. Wellar, “Non-Traditional Machining Processes”, SME, Michigan, 1984.

2. Gary F. Benedict, “Non-traditional Manufacturing Processes”, Marcel Dekker, 1987.

Additive Manufacturing

BTMPE703E	PEC5	Additive Manufacturing	3-0-0	4Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Understand the importance of Additive Manufacturing
CO2	Classify the different AM processes
CO3	Design for AM processes
CO4	Understand the applications of AM
CO5	Differentiate the post processing processes

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	2	2					1

CO2	2	2	3	3	3	3	1					1
CO3	2	2	3	3	3		2					1
CO4	3	3	3	2	2	2	2					1
CO5	2	3	3	2	2	2	2					1

Course Contents:

Unit 1: Introduction to Additive Manufacturing (AM)
Introduction to AM, AM evolution, Distinction between AM and CNC machining, Advantages of AM.
AM process chain: Conceptualization, CAD, conversion to STL, Transfer to AM, STL file manipulation, Machine setup, build , removal and clean up, post processing.
Classification of AM processes: Liquid polymer system, discrete particle system, molten material systems, and solid sheet system.

Unit 2: Design for AM
Motivation, DFMA concepts and objectives, AM unique capabilities, Exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers etc.

Unit 3: Guidelines for Process Selection
Introduction, selection methods for a part, challenges of selection, example system for preliminary selection, production planning and control

Unit 4: AM Applications
Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Re-manufacturing. Application examples for Aerospace, defence, automobile, Bio-medical and general engineering industries

Unit 5: Post Processing of AM Parts and Future Directions of AM
Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques.
Future Directions of AM
Introduction, new types of products, employment and digiproneurship.

Texts:
1. Chua Chee Kai, Leong Kah Fai, “Rapid Prototyping: Principles and Applications”, World Scientific, 2003.
2. Ian Gibson, David W. Rosen, Brent Stucker, “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2nd edition, 2010.

References:

1. Ali K. Kamrani, EmandAbouel Nasr, "Rapid Prototyping: Theory and Practice", Springer, 2006.
2. D. T. Pham, S. S. Dimov, "Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling", Springer, 2001.
3. Andreas Gebhardt, "Understanding Additive Manufacturing", Hanser Publishers, 2011.

Surface Engineering

BTMPE703F	PEC5	Surface Engineering	3-0-0	3Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to

CO1	Learn the importance and need of surface engineering
CO2	Describe various surface cleaning and modification techniques
CO3	Understand the concepts of surface integrity
CO4	Compare various surface coating technologies
CO5	Select appropriate method of coating for a given application
CO6	Apply measurement techniques and carry out characterization of coated surfaces.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		1							1		1
CO2	2				2							
CO3	2	2	1	2						1		
CO4	2				1	1		1		1		
CO5	2	2	1		1		1	1	1	1	1	
CO6	2	2	1	2	2			1	1	1		

Course Contents:

Unit 1: Introduction

Definition, Significance, Role of surface Engineering in creating high performance product, Functional characteristics of a surface, Nature of surfaces: Deformed layer, Beilby layer, chemically reacted layer, Physisorbed layer, Chemisorbed layer; Classification of Surface Engineering Techniques.

Unit 2: Surface Preparation Techniques

Factors affecting selection of cleaning process, Significance of surface preparation, Classification of cleaning processes, Chemical cleaning processes; Mechanical Processes; Substrate considerations, Surface contaminants or soils, Tests for cleanliness.

Unit 3: Surface Integrity

Definition, Importance, Surface alterations, Factors in Surface Integrity: Visual, Dimensional, Residual stress, Tribological, Metallurgical; Measuring Surface Integrity effects: Minimum and Standard data set, Macroscopic and microscopic examination.

Unit 4: Surface Modification Techniques

Classification, Thermal treatments: Laser and electron beam hardening, Mechanical treatments: Short peening: Peening action, surface coverage and peening intensity, Types and sizes of media, Control of process variables, equipment;

Ion Implantation: Basic Principle, Advantages and disadvantages, equipment.

Unit 5: Surface Coating Techniques and Characterization of Coatings

Thermal Spraying: Types and applications; Chemical Vapour Deposition: Principles, Reactions, Types and applications; Physical Vapour Deposition: Basic principle, Evaporation, Sputtering, Ion Plating, Applications; Electroplating: Principle of working and applications; Types of Coatings: Hard, Soft, Single layer, Multi-layer.

Characterization of Coatings

Physical characteristics and their measurements: Coating thickness, Surface Morphology and Microstructure. Mechanical properties and their Measurements: Hardness, Adhesion, Friction and Wear.

References:

1. ASM Handbook, “Volume 5: Surface Engineering”, ASM International.
2. K. G. Budinski, “Surface Engineering for Wear Resistance”, Prentice Hall.
3. T. Burakowski, T. Wierschon, “Surface Engineering of Metals: Principles, Equipment, Technologies”, CRC Press.

4. B. Bhushan, B. K. Gupta, "Handbook of Tribology: Materials, Coatings, and Surface Treatments", Tata McGraw Hill Publications.
ASM Handbook, "Volume 16: Machining", ASM International.

Open Elective-III

Sustainable Development

BTMOE704A	OEC3	Sustainable Development	3-0-0	Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Explain the difference between development and sustainable development
CO2	Explain challenges of sustainable development and climate change
CO3	Explain sustainable development indicators
CO4	Analyze sustainable energy options
CO5	Understand social and economic aspects of sustainable development

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	3		2	3	3	3	2	2		2
CO2	1	1	3	1	2	3	3	3	2	2		2
CO3	2	1	1				3	2		1		2
CO4	3	3			2	3	3	2				1
CO5			3			2	3	2				1

Course Contents:

Unit 1: Introduction
Status of environment, Environmental, Social and Economic issues, Need for sustainability, nine ways to achieve sustainability, population, resources, development and environment.

Unit 2: Global Warming and Climate Change
Global Warming and climate Change since industrial revolution, Greenhouse gas emission, greenhouse effect, Renewable energy, etc.

Unit 3: Challenges of Sustainable Development and Global Environmental Issues
Concept of sustainability, Factors governing sustainable development, Linkages among sustainable development, Environment and poverty, Determinants of sustainable development, Case studies on sustainable development, Population, income and urbanization Health care, Food, fisheries and agriculture , Materials and energy flows.

Unit 4: Sustainable Development Indicators and Environmental Assessment

Need for indicators, Statistical procedures Aggregating indicators, Use of principal component analysis, Three environmental quality indices.
Environmental Assessment
National environmental policy act of 1969, Environmental Impact Assessment, Project categories based on environmental impacts, Impact identification methods, Environmental impact assessment process.

Unit 5: Environmental Management and Social Dimensions
Revisiting complex issues, Sector policies concerning the environment, Institutional framework for environmental management, Achievements in environmental management, People's perception of the environment, Participatory development, NGOs, Gender and development, Indigenous peoples, Social exclusion and analysis.

Texts:
1. J. Sayer, B. Campbell, "The Science of Sustainable Development: Local Livelihoods and the Global Environment", Biological Conservation, Restoration and Sustainability, Cambridge University Press, London, 2003.
2. J. Kirkby, P. O"Keefe, Timberlake, "Sustainable Development", Earth scan Publication, London, 1993.

3. Peter P. Rogers, Kazi F. Jalal, John A. Boyd, "An introduction to sustainable development", Glen Educational Foundation, 2008.

References:

1. Jennifer A. Elliott, "An introduction to sustainable development". London: Routledge: Taylor and Francis group, 2001.
2. Low, N. "Global ethics and environment", London, Rout ledge, 1999.
3. Douglas Muschett, "Principles of Sustainable Development", St. Lucie Press, 1997.

Entrepreneurship Development

BTMOE704B	OEC 4	Entrepreneurship Development	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	enlarge the supply of entrepreneurs for rapid industrial development
CO2	Develop small and medium enterprises sector which is necessary for generation of employment
CO3	Industrialize rural and backward regions
CO4	Provide gainful self-employment to educated young men and women
CO5	Diversify the sources of entrepreneurship.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									2			
CO2									2			
CO3											2	
CO4											2	3
CO5												3

Course Contents:

Unit 1: Introduction to Entrepreneurship
Evolution of the Concept of Entrepreneur Functions of Entrepreneur, Characteristics of an Entrepreneur, Types of Entrepreneur, Concept of Entrepreneurship, Growth of Entrepreneurship, Barriers of Entrepreneurship, Role of Entrepreneurship in India, Entrepreneurial Motivation, Major Entrepreneurial Competencies.

Unit 2: Small Scale Industries (SSI)
Characteristics of Small Scale Industry, Basis for Classification of Small Scale Industry: Resource Based, Demand Based, Ancillary, Subsidiary Based or Sub-Controlled Type, Technology Based etc. Government Policy for Small Scale Industry, Growth of SSI in Developing Countries, Role of National and State Agencies Providing Assistance To SSI's, Relationship between Small and Big Industries, Ownership Structure, Registration of SSI.

Unit 3: Project Identification and Project Formulation
Meaning of Project, Project Identification and Selection, Elements of Project Formulation, Concept and Significance of Project Formulation, Meaning, Significance and Contents of Project Report.
Accounting for Small Enterprises: Objective of Accounting, Accounting Process, Journal, Ledger, Preparation of Balance Sheet and Assessment of Economic Viability

Unit 4: Project Appraisal
Concept of Project Appraisal, Project Appraisal Methods, Cash Flows as Costs and Benefits, Payback Period, Average Rate of Return. Discounted Cash Flow Techniques, Working Capital Management, Cost of Capital, Financing of Enterprises, Project Sickness & Corrective Measures.

Unit 5: Marketing Management
Market Segmentation, Marketing Mix, and Packaging, Pricing Policy, Distribution Channels, and Govt. Purchases from SSIS.
Laws Concerning Entrepreneur: Income Tax Laws, Excise Duty ,The Central Sales Tax Act, Professional Tax, Value Added Tax (VAT), Service Tax, The Workmen Compensation Act, The Minimum Wages Act, The Maternity Benefit Act, The Payment of Bonus Act
Institutional Support
Government Policies for Small Scale Entrepreneurs, Institutional Setup, District Industries Centers, Industrial Estates , SIDCO, NSIC, Directorate of Industries, Commercial Banks, New Entrepreneurial Development Agencies.
Women Entrepreneurship: Growth, Problems, Recent Trends.

References:

1. S. S. Khanka, "Entrepreneurial Development", S. Chand and Company Ltd.
2. C. B. Gupta, N. P. Srinivasan, "Entrepreneurship Development in India", S. Chand and Sons.
3. B. Badhai, "Entrepreneurship Development Programme", Mansell Publishing Ltd.
4. V. Desai, "Dynamics of Entrepreneurial Development and Management", Hindustan Publishing House.
5. David H. Holt, "Entrepreneurship", PHI Learning.
6. Roy Rajeev, "Entrepreneurship", Oxford University Press.

Plant Maintenance

BTMOE704C	OEC3	Plant Maintenance	3-0-0	3Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Objectives: To exemplify different types of plants and its function and analyse the principles used in plants maintenance. To understand various basic aspects related to running of industry the safety methods in plants. This course provides problems based techniques related with location, layout, maintenance, replacement of machines, etc.
Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Recognize and enlist probable failures in mechanical elements.
CO2	Dismantle, assemble and align mechanisms in sequential order for given assembly.
CO3	Compare maintenance practices like on-line, shut down, corrosion, productive and preventive maintenance.

CO4	Analyze economics of plants and list factors affecting the maintenance of a plant.
CO5	Correlate the linkages between different maintenance aspects and how they impact on overall maintenance effectiveness.
CO6	Analyze different maintenance techniques and select an appropriate technique for a particular plant.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		2	2		1	2	1	1	2			2
CO2	2			1	1	2	2					2
CO3	2	2	1	1	1		1	1	1			
CO4	1	1		2	1	2	1		2		1	2
CO5	2	2			1	2	2				1	2
CO6	1					1					1	1

Course Contents:

Unit 1: Introduction

Introduction to concept of maintenance, Type of maintenance; Preventive, Productive, corrective, online, shut down and their significance.

Unit 2: Preventive Maintenance

Preventive maintenance and its importance, Repair cycle, systematic recording, preventive maintenance, Programming and types of schedules, Manpower and machine planning, Lubrication methods and practice, Color code schedule.

Unit 3: Online Maintenance and Shut down Maintenance

On-line maintenance, attending to joints, Valves, Pumps and other equipment's leakages, Making shaft arrangement, stand-by unit, repairing damage to insulation, etc. without stopping the plant, attending faulty equipment, Fault finding and troubleshoots.

Shut down Maintenance

Shut down maintenance, Economic aspects of timing, duration of Timing and duration of shut down maintenance, Execution by using PERT and CPM.

Unit 5: Maintenance of Mechanical Equipment

Maintenance of major equipment like boiler, furnaces, kilns, shells and tube heat exchangers, pump and compressor, Towers, Cooling vessels, Valves piping.

Unit 6: Plant Condition Monitoring

Plant condition monitoring systems, instrumentation, Data collection and analysis, life expectancy and maintenance scheduling. The economics of maintenance management.

Text:

1. Lindley R. Hinggin, L.C. Morrow, "Maintenance Engineering Handbook", Tata McGraw Hill Book Company.

References:

1. Duncan C. Richardson, PE, "Plant Equipment and Maintenance Engineering Handbook", McGraw Hill Education, New York, Chicago, 2014.

Open Elective-IV

Engineering Economics

BTMOE705A	OEC4	Engineering Economics	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Apply the appropriate engineering economics analysis method(s) for problem solving: present worth, annual cost, rate-of-return, payback, break-even, Benefit-cost ratio.
CO2	Evaluate the cost effectiveness of individual engineering projects using the methods learned and draw inferences for the investment decisions.

CO3	Compare the life cycle cost of multiple projects using the methods learned, and make a quantitative decision between alternate facilities and/or systems.
CO4	Compute the depreciation of an asset using standard Depreciation techniques to assess its impact on present or future value.
CO5	Apply all mathematical approach models covered in solving engineering economics problems: mathematical formulas, interest factors from tables, Excel functions and graphs. Estimate reasonableness of the results.
CO6	Examine and evaluate probabilistic risk assessment methods.
CO7	Compare the differences in economic analysis between the private and public sectors. Recognize the limits of mathematical models for factors hard to quantify.
CO8	Develop and demonstrate teamwork, project management, and professional communications skills

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1											3	
CO2											3	
CO3											3	
CO4											3	
CO5					3						3	
CO6											3	
CO7											3	
CO8									2		3	

Course Contents:

Unit 1: Introduction to Economics

Introduction to Economics: Flow in an economy, Law of supply and demand, Concept of Eng**i**neering Economics: Engineering efficiency, Economic efficiency, Scope of engineering economics - Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis: V ratio, Elementary economic Analysis: Material selection for product Design selection for a product, Process planning.

Unit 2: Value Engineering

Make or buy decision, Value engineering: Function, aims, and Value engineering procedure. Interest formulae and their applications: Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor: equal payment series capital recovery factor:

Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.

Unit 3: Cash Flow

Methods of comparison of alternatives: present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost

dominated cash flow diagram), rate of return method, Examples in all the methods.

Unit 4: Replacement and Maintenance Analysis

Replacement and Maintenance analysis: Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset: capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely.

Unit 5: Depreciation and Evaluation of Public Alternatives

Depreciation: Introduction, Straight line method of depreciation, declining balance method of depreciation, sum of the years digits method of depreciation, sinking fund method of depreciation/annuity method of depreciation, service output method of depreciation-

Evaluation of Public Alternatives

Introduction, Examples, Inflation adjusted decisions: procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset.

Texts:

1. PanneerSelvam R, “Engineering Economics”, Prentice Hall of India Ltd, New Delhi, 2001.

References:

1. Chan S. Park, “Contemporary Engineering Economics”, Prentice Hall of India, 2011.
2. Donald G. Newman, Jerome P. Lavelle, “Engineering Economics and analysis”, Engineering Press, Texas, 2010.
3. E. P. Degarmo, W. G. Sullivan and J. R. Canada, “Engineering Economy”, Macmillan, New York, 2011.
4. Zahid A. Khan, "Engineering Economy", Dorling Kindersley, 2012

Biology for Engineers

BTMOE705B	OEC 4	Biology for Engineers	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Explain origin of life and Evolution, Cells, Biomolecules-Lipids
CO2	Understand Biomolecules
CO3	Understand Cell structure and function and cell cycle
CO4	Explain Mendelian genetics
CO5	Understand and Explain DNA structure, DNA replication, Transcription, Translation

Mapping of course outcomes with program outcomes

Course	Program Outcomes

Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	3		1		1			1		1
CO2	1	2	3		1		1			1		1
CO3	1	2	3		1		1			1		1
CO4	1	2	3		1		1			1		1
CO5	1	2	3		1		1			1		1

Course Contents:

Unit 1: Introduction
Origin of life and Evolution, Cells, Biomolecules-Lipids

Unit 2: Biomolecules
Carbohydrates, water, Amino acids and proteins, Enzymes, Nucleotides

Unit 3: Cell structure
Cell structure and function, Prokaryotes, Eukaryotes

Unit 4: Cell cycle
Cell division, mitosis, meiosis, culture growth,

Unit 5: Genetics and DNA
Mendelian genetics, genetic disorders, Mendelian inheritance principle, pedigree analysis, Non-Mendelian inheritance
DNA
Chromatin, DNA structure, DNA replication, Transcription, Translation.
Texts:
1. Arthur T. Johnson, “Biology for Engineers”, CRC Press.

References:
1. N. A. Campbell, J. B. Reece, “Biology”, International edition, Benjamin Cummings, New York, 7th edition or later, 2007 or later.
2. G. Karp, “Cell and Molecular Biology: Concepts and Experiments”, Wiley, New York, 7th edition, 2013.

Intellectual Property Rights

BTMOE705C	OEC4	Intellectual Property Rights	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	State the basic fundamental terms such as copyrights, Patents, Trademarks etc.,
CO2	Interpret Laws of copy-rights, Patents, Trademarks and various IP registration Processes.
CO3	Exhibit the enhance capability to do economic analysis of IP rights, technology and innovation related policy issues and firms commercial strategies.
CO4	Create awareness at all levels (research and innovation) to develop patentable technologies.

CO5	Apply trade mark law, copy right law, patent law and also carry out intellectual property audits.
CO6	Manage and safeguard the intellectual property and protect it against unauthorized use.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1											
CO2								1				
CO3		1						1				
CO4										1		
CO5	1							1				
CO6								2				

Course Contents:

Unit 1: Introduction to Intellectual Property
Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights.

Unit 2: Trade Marks
Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting and evaluating trade mark, trade mark registration processes.

Unit 3: Law of Copy Rights
Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law.

Unit 4: Law of Patents and Trade Secrets
Foundation of patent law, patent searching process, ownership rights and transfer.

Trade Secrets
Trade secretes law, determination of trade secretes status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation.

Unfair competition: Misappropriation right of publicity, false advertising.

Unit 5: New Development of Intellectual Property
New developments in trade mark law; copy right law, patent law, intellectual property audits.
International overview on intellectual property, international trade mark law, copy right law, international patent law, and international development in trade secrets law.

Texts:

1. Deborah, E. Bouchoux, “Intellectual Property Right”, Cengage learning.

2. PrabuddhaGanguli, “Intellectual property right: Unleashing the knowledge economy”, Tata McGraw Hill Publishing Company Ltd.

References:

1. AjitParulekar, Sarita D'Souza, "Indian Patents Law-Legal and Business implications", Macmillan India Ltd., 2006.
2. B. L. Wadhera, "Law related to patents, Trademarks, Copyrights, Designs and Geographical indications", Universal law Publishing Pvt. Ltd., India, 2000.
3. P. Narayanan, "Law of copyright and Industrial Designs", Eastern Law house, Delhi, 2010.

Production Engineering Lab-V

BTPCL706	PCC16	**Production Engineering Lab V**	0-0-4	4 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 4hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

List ofPractical's/Experiments/Assignments (Any 5 from Group-A and Any 5 from Group-B):

Group-A (Mechatronics):

1. Study and demonstration of various types of sensors
2. Speed control of various types of Electrical Motors
3. Minimum two circuits on Pneumatics to be developed on Pneumatic trainer kit

4. Minimum two circuits on Electro-Pneumatics to be developed on Electro- Pneumatic trainer kit
5. Minimum two circuits on Hydraulics and Electro-hydraulics to be developed on Hydraulic trainer kit
6. Programming of Microprocessor and Microcontroller
7. Programming on PLC
8. Demonstration of Process control such as temperature, level, flow, etc. control using PID controller

Group-B (Tool Design Practice):

1. Drawing and Design of Single Point Tool.
2. Design of Drill Jig (Assembly & Bill of Material)
3. Design of Milling Fixture (Assembly & Bill of Material)
4. Design and Drawing of two Drilling / Reaming jigs. (Details of at least one Sheet showing Manufacturing Drawing with Tolerances, Material Specification and Heat Treatment)
5. Design of Broach.
6. Design Multi impression forging Die.
7. Design of Press Tool.
8. Design Bending and Drawing Dies.
9. Design of Simple Two Plate Injection Moulds.
10. Assignments based on the Topics Covered in the Theory Course.

IT – 3 Evaluation

PROJ-5	BTPI608 (IT – 3)	IT – 3 Evaluation	-	-	-	-	-	100	100	1

Semester VIII

Project work/ Internship

Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				Credit
			L	T	P	CA	MSE	ESE	Total	
PROJ-6	BTPP801/ BTPI801	Project work/ Internship	-	-	24	60	-	40	100	12
Total			**-**	**-**	**24**	**60**	**-**	**40**	**100**	**12**

Sr. No.	Semester	Course Code	Name of Subject as per Curriculum	Equivalent SWAYAM/ NPTEL Courses	Name of courseInstitute offering	Relevance %	Duration of course

B. Tech. in Production Engineering

List of courses with their equivalent SWAYAM courses:

1	Semester I	BTBS101	Engineering Mathematics-I	Engineering Mathematics - I	IIT Kharagpur	20%	12 week
2		BTBS102	Engineering Physics	Engineering Physics	IIT Roorkee	20%	10 week
3		BTES103	Engineering Graphics	Engineering Graphics	IIT Kanpur	50%	8 week
				Technical Art	IIT Kanpur	80%	10 week
4		BTHM104	Communication Skills	Communication Skills	IIT Kanpur	40%	10 week
5		BTES105	Energy and Environment Engineering				
6		BTES106	Basic Civil and Mechanical Engineering	Introduction to Civil Engineering	IIT Madras	10%	1 week
7	Semester II	BTBS201	Engineering Mathematics-II	Engineering Mathematics II	IIT Kharagpur	20%	12 week
				Engineering Mathematics - I	IIT Kharagpur	20%	12 week
8		CHM202	Engineering Chemistry	Introduction to corrosion-1	IIT Kanpur	20%	1 week
				Types and forms of Corrosion	IIT Kanpur		1 week
9		BTES203	Engineering Mechanics	Engineering Mechanics	IIT Madras	60%	12 week
				Engineering Mechanics	IIT Guwahati	60%	12 week
10		BTES204	Computer Programming	Introduction to programming in C	IIT Kanpur	60%	12 week
11		BTES205	Basic Electrical and Electronics Engineering	Fundamentals of Electrical Engineering	IIT Kharagpur July 2018	40%	12 week
12	3rd	BTBS301	Engineering Mathematics – III	Differential equations for engineers			12 Weeks
13		BTMC302	Fluid Mechanics	Fluid mechanics	IIT Kharagpur	80	12 Weeks
14		BTAC303	Engineering Thermodynamics and heat transfer	1.Heat and mass transfer 2.Basic thermodynamics 3.Fundamentals of combustion	IIT Bombey, IIT Kharagpur, IIT Kanpur	80	1. 8 Weeks 2. 8 Weeks 3. 8 Weeks
15		BTMES304	Materials Science and Metallurgy	1.Metallurgy and material science 2.Material science and engineering	IIT Delhi, IIT Roorkee	80	1. 12 Weeks 2. 8 Weeks
16	4th	BTPC401	Casting &Moulding Technology	1.Principles of casting technlogy 2.Metal casting	IIT Roorkee	70	1. 8 Weeks 2. 6 Weeks
17		BTPC402	Theory of Machines	Theory of machines,	IIT Madras	20	10 Weeks
18		BTHM403	Basic Human Rights	No course available			
19		BTMES404	Strength of Materials	Strength of Materials	IIT Kharagpur	85	10 Weeks
20		BTMPE405 A	Applied Thermodynamics	1.Applied Thermodynamics for engineers 2.Thermodynamics	IIT Guwahati, IIT Delhi	70	1. 12 Weeks 2. 12 Weeks
21		BTMPE405B	Numerical Methods in	Numerical methods and	IIT Delhi	60	10 Weeks

			Mechanical Engineering	computation			
22		BTMPE405C	Sheet Metal Engineering	Principles of metal forming technology	IIT Roorkee	40	8 Weeks
23		BTMPE405 D	Fluid Machinery	Fluid machines	IIT Kharagpur	70	8 Weeks
24	Semester V	BTPC501	Design of Machine Elements	Design of Machine Elements	IIT Kharagpur	70%	12 week
				Machine Desigh-II	IIT Madras	40%	12 week
				Design of Machine Elements I	IIT Kharagpur	50%	10 week
25		BTPC502	Metal Forming Processes	Principles of Metal Forming Technology	IIT Roorkee	90%	10 week
				Fundamental concepts of metal forming technology	SASTRA University, Thanjavur-613 401	50%	10 week
26		BTPC503	Joining Technology	Joining Technologies for metal	IIT Roorkee	80%	8 week
				Advances in welding and joining technologies	IIT Guwahati	40%	6 week
27		BTMPE504 A	Elective-II Metrology and Quality Control	Engineering Metrology	IIT Kanpur	70%	12 week
				Mechanical Measurements and Metrology	IIT Madras	40%	12 week
				Metrology - Mechanical Engineering -	IIT Madras	80%	12 week
				Inspection & Quality Control in Manufacturing	IIT Roorkee	40%	4 week
28		BTMPE504B	Elective-II Refrigeration and Air conditioning	Refrigeration and air-conditioning	IIT Roorkee	60%	8 week
				Refrigeration and air-conditioning	IIT Kharagpur	60%	12 week
29		BTMPE504E	Elective-II Engineering Tribology	Tribology	IIT Delhi	90%	6 week
				Tribology	IIT Delhi	190%	10 week
				Wear & Corrosion	IIT Roorkee	10%	10 week
				Effect of Tribology on Surface of Nanomaterials	IIT Roorkee	10%	10 week
				Lubrication	IIT Roorkee	10%	10 week
				Tribology & Its Classification	IIT Roorkee	10%	10 week
30		BTAPE504A	Elective-II Automobile Design				

31		BTAPE504D	Elective-II Automobile Engineering	Fundamentals of Automotive Systems	IIT Madras	100%	12 week
				Engineering Design - Vehicle Dynamics	IIT Madras	50%	8 week
32		BTMOE505 A	Open Elective-I Solar Energy	Principles and Performance of Solar Energy Thermal Systems	IIT Kharagpur	80%	12 week
				Introduction to Solar Energy	IIT Kanpur	10%	12 week
33		BTMOE505 B	Open Elective-I Renewable Energy Sources	Energy Resources and Technology	IIT Kharagpur	60%	10 week
				Technologies For Clean And Renewable Energy Production	IIT Roorkee	60%	8 week
34		BTMOE505 C	Open Elective-I Human Resource Management	Principles of Human Resource Management	IIT Kharagpur	80%	8 week
				Human Resource Management-I	IIT Kharagpur	40%	6 week
35		BTMOE505 D	Open Elective-I Product Design Engineering	Product Design and Innovation	IIT Guwahati	50%	4 week
				Product Design and Manufacturing	IIT Kanpur	50%	12 week
36	Semester VI	BTPC601	Machine Tools and Metal Cutting	metal cutting and machine tools	IIT Kharagpur	50%	6 week
37		BTPC602	CAD/CAM/CIM	Computer Aided Engineering Design	IIT Kanpur	60%	10 week
				Computer Aided Design and Manufacturing	IIT Delhi	70%	12 week
38		BTPPE603A	Elective-III Robotics & Automation	Robotics and Control : Theory and Practice	IIT Roorkee	50%	8 week
				Robotics	IIT Kharagpur	50%	8 week
				Robotics	IIT Bombay	40%	10 week
39		BTPPE603B	Elective-III Assembly Planning & Management				
40		BTMPE603 A	Elective-III IC Engines	IC Engines and Gas Turbines	IIT Guwahati	60%	8 week
				Introduction to Hybrid and Electric Vehicles	IIT Guwahati	20%	10 week
41		BTMPE603B	Elective-III	Mechanical Vibrations	IIT Guwahati	100%	12 week

			Mechanical Vibrations	Introduction to mechanical vibration	IIT Roorkee	40%	8 week
42		BTMPE603C	Elective-III Machine Tool Design				
43		BTAPE603C	Elective-III Automobile Body Design (Pre-requisite: Automobile Design)	Welding of Advanced High Strength Steels for Automotive Applications	IIT Madras	40%	4 week
44		BTPPE604A	Elective-IV Production Planning and Control	Operations Management	IIT Roorkee	40%	12 week
45		BTPPE604B	Elective-IV Flexible Manufacturing Systems	Manufacturing Systems Management	IIT Madras	60%	10 week
46		BTMPE604 A	Elective-IV Process Equipment Design	Equipment Design: Mechanical Aspects	IIT Roorkee	70%	4 week
47		BTMPE604B	Elective-IV Product Life Cycle Management	Prodeuct design and development	IIT Roorkee	20%	4 week
				Operations Management	IIT Roorkee	20%	12 week
48		BTMPE604C	Elective-IV Finite Element Method	Introduction to Finite Element Method	IIT Madras	40%	8 week
				Finite Element Method	IIT Kanpur	40%	12 week
49		BTAPE604B	Elective-IV Computational Fluid Dynamics	Foundation of Computational Fluid Dynamics	IIT Madras	40%	8 week
				Computational Fluid Dynamics	IIT Madras	40%	12 week
				Computational Fluid Dynamics	IIT Roorkee	40%	12 week
				Computational Fluid Dynamics	IIT Kharagpur	50%	12 week
50		BTMOE605 A	Open Elective-II Quantitative Techniques and Project Management	project and production management	IIT Delhi	30%	10 week
51		BTMOE605 B	Open Elective-II Nanotechnology	Nanotechnology, Science and Applications	IIT Madras	70%	8 week

				Nanostructures and Nanomaterials: Characterization and Properties	IIT Kanpur	40%	12 week
52		BTMOE605 C	Open Elective-II Energy Conservation and Management	Waste to Energy Conversion	IIT Roorkee	30%	8 week
53		BTMOE605 D	Open Elective-II Wind Energy	Energy resources and technology	IIT Kharagpur	60%	10 week
54		BTMOE605 E	Open Elective-II Introduction to Probability Theory and Statistics	Introduction to probability and Statistics	IIT Madras	30%	4 week
				Probability and Statistics	IIT Kharagpur	50%	12 week
55	7th	BTMC701	Mechatronics	Mechatronics and Manufacturing Automation	IIT, Guwahati	60	6 Weeks
56		BTHM702	Industrial Engineering and Management	Principles of industrial engineering	IIT, Roorkee	80	12 Weeks
57		BTPPE703A	Tool Design	Manufacturing process-II	IIT Kharagpur	50	10 Weeks
58		BTPPE703B	Reliability and Terotechnology	No course available			
59		BTPPE703C	Modeling of Manufacturing Systems	1.Manufacturing systems management 2.Introduction to stochastic processes and its applications	IIT Madras	50	1.10 Weeks 2. 12 Weeks
60		BTPPE703D	Processing of Polymers	Processing of polymers and polymer composites	IIT Roorkee	70	8 Weeks
61		BTMPE703B	Biomechanics	Mechanics of human movement	IIT Madras	40	12 Weeks
62		BTMPE703C	Non-conventional Machining		IIT Kharagpur, IIT Guwahati, IIT Kanpur	70	1. 4 Weeks 2. 8 Weeks 3. Weeks
63		BTMPE703E	Additive Manufacturing	No course available			
64		BTMPE703F	Surface Engineering	Fundamentals of surface engineering	IIT Roorkee	70	12 Weeks
65		BTMOE704 A	Sustainable Development	No course available			
66		BTMOE704 B	Entrepreneurship Development	1.Entrepreneurship 2.Entrepreneurship essentials 3.Innovation business models and entrepreneurship	IIT Madras, IIT Kharagpur, IIT Roorkee	70	1. 12 Weeks 2. 12 Weeks 3. 8 Weeks

67		BTMOE704 C	Plant Maintenance	Machinary fault diagnosisand signal processing	IIT Kharagpur	30	10 Weeks
68		BTMOE705 A	Engineering Economics	Engineering economic analysis	IIT Roorkee	40	8 Weeks
69		BTMOE705 B	Biology for Engineers	Biology for engineers and other non-biologists	IIT Madras	50	4 Weeks
70		BTMOE705 C	Intellectual Property Rights	1.Intellectual property rights and compitition law 2.Intellectural property	IIT Kharagpur, IIT Madras	50	1. 8 Weeks 2.11 Weeks